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TITLE ANALYSIS OF WFT-709 FLIGHT TESTS OF NAVIGATOR'S COMPARTMENT DEFROSTING SYSTEM

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FOREWORD

The navigator's (or "nose") compartment defrost system configuration of the first 16 production Airplanes, as represented by the first production RB-47E AF 51-5258, has been flight tested as proposed by Wichita Flight Test Proposal No. 352 (Reference 9). The flight tests of the navigator's and camera compartment defrosting systems were conducted simultaneously in accordance with the outline for Flight Test WFT-0-709C (Reference 4), except for those deviations listed in Flight Test Plans, Conference and Data Document RB-47E airplane AF 51-5258, WD-13564, (Insert 2).

This document presents an analysis of the navigator's compartment defrost system performance for the Airplanes S/N 51-5258 through 51-5273 based on the results of WFT 709B. Analysis of the camera compartment defrosting system is presented in Reference 11.

The system, Figure 1, was designed to provide a frost and fog-free nose camera and viewfinder window during all conditions of steady and transient state flight. The nose cover and scan windows were designed with marginal protection during a transient state flight. Defrosting protection is provided by directing a hot air jet across the outside surface of the nose camera and viewfinder windows and across the inside surface of the nose cover and both scan windows. Additional protection is provided simultaneously with outside defrosting for the nose camera and viewfinder windows by passing recirculated cabin air over the inside surfaces. The recirculated navigator's compartment air on the inside surface also provides increased protection during doors-open operation. The design was based on atmospheric conditions defined by Military Specification MIL-T-5842A (Reference 1).

Evaluation of flight test data will be based on system performance for two simulated typical photo reconnaissance missions:

(a) High altitude photo reconnaissance at 40,000 ft. combat cruise preceded by cruise climb (Mach. .74) to target area.

(b) Low altitude photo reconnaissance during high speed dash at 1,000 feet above sea level, preceded by a cruise climb (Mach. .74) and a maximum rate descent to target area.

These missions are considered to cover the most critical RB-47E flight conditions from the defrosting standpoint.

SUMMARY

The navigator's compartment defrost system per the configuration of RB-47E airplane AF 51-5258 is marginal in providing a frost-free nose camera and viewfinder window during a high altitude maximum range cruise photo-reconnaissance mission. The system will satisfactorily maintain the nose cover and both scan windows free from frost during this condition. The system is deficient at the start of a low altitude mission which is preceded by a maximum rate descent from high altitude. Recommendations are made for improvement of system performance during this latter condition. It is believed these changes will also provide additional protection against frost during the high altitude photo-mission.

The temperature control system functioned satisfactorily whenever the defrost system operation was free from malfunctions of other components of the defrosting system. The modulation valve operation was stable during all normal defrosting system operating conditions. The control system that closes the modulation valve when both cover doors are open, failed to operate satisfactorily. The only major indications of control temperature fluctuations and/or modulation valve hunting were experienced as the result of the failure of the control system to close the modulation valve during doors open operations according to the system design. Defrost blower operation was satisfactory at high altitude but was erratic during low altitude conditions. The erratic condition is attributed to the fluctuations in bleed airflow. All other system components appeared to have functioned satisfactorily.

REFERENCES

ITEM		SUBJECT
1.	Military Specification MIL-T-5842A Dated 13 July 1953	Transparent Areas, Defrosting Systems General Specifications for
2.	Boeing Airplane Company Document D-12207 Model RB-47B Dated 15 January 1952	An Analysis of the Defrosting Systems
3.	Boeing Airplane Company Test Report T-28288 Model RB-47B Dated 1 September 1954	Performance Test of Crew Compartment Defrosting System
4.	Boeing Airplane Company Outline for Flight Test Reference No. 0-709, Rev. C Dated 19 March 1954	Camera Compartment and Cabin Compartment Defrosting System
5.	Boeing Airplane Company Drawing 5-60798, Rev. A	Modification Installation Air-Moisture Separator, Cabin Air
6.	Boeing Airplane Company Drawing 9-43699	Valve Assembly Moisture Separator By Pass
7.	Boeing Airplane Company Document WD-13400-41 Dated 15 September 1954	Flight Test Activities Report
8.	Boeing Airplane Company Document WD-13400-29 Dated 15 March 1954	Flight Test Activities Report
9.	Boeing Airplane Company Proposal for Flight Test Reference No. 352 Dated 23 June 1953	Camera Compartment and Cabin Defrosting Systems - Model RB-47E
10.	American Society of Heating and Air Conditioning Engineers, Inc. New York, N.Y. 33rd Edition, Copyright 1955	Heating, Ventilating, Air Conditioning Guide

11. Boeing Airplane Company
Document WD-14016
Model RB-47E
Analysis of the WFT 709 Flight Test of the RB-47E Camera Compartment Defrosting System

12. Boeing Airplane Company
Document WD-14014
Model RB-47E
Analysis of WFT 708 Flight Test Data on RB-47E Cabin Compartment Air Conditioning System

13. Boeing Airplane Company
Drawing 5-45626, Rev. D
Model RB-47E
System Installation, Air Conditioning and Pressurization

14. Boeing Airplane Company
Drawing 5-45628, Rev. C
Model RB-47E
Control Installation, Defrost and Camera Ventilation, Section 49

15. Boeing Airplane Company
Document D-13559
Research
dated 27 August 1954
Effects of an Air Conditioning System Moisture Separator on Cabin Dew Point Temperature

16. Boeing Airplane Company
Document D-13341
Model RB-47B
dated 17 December 1952
Analysis of Cabin Air Conditioning System

17. International Text Book Co.
Scranton, Pennsylvania
(Publisher)
Second Edition, Copyright 1944
Air Conditioning and Refrigeration
Burgess H. Jennings and Samuel R. Lewis

DESCRIPTION OF SYSTEM

A. Navigator Compartment Defrost System

The navigator's compartment(nose)defrost system of the first production RB-47E was in accordance to Boeing installation drawing 5-45626, Reference 13, as applicable to airplane AF 51-5258 and is shown isometrically in Figure 1 and schematically in Figure 2. This system provides hot air for defrosting the outside of the nose camera and viewfinder windows, and cabin air for ventilating the nose camera and defogging the inside of the nose camera and viewfinder windows. Hot air may also be bled from the system for defrosting the inside surfaces of the nose cover window and observer's scan windows. When the nose compartment defrost system is "ON", the nose defrost blower forces cabin air through a duct which mixes part of the blower air with bleed air from engines 1, 2, and 3. The temperature of the resultant mixed air is automatically regulated to 160 ± 5°F by a temperature control system. The rest of the blower air is circulated through a duct supplying the inside defrost system for the viewfinder and forward oblique camera window and ventilation for the camera. The temperature of the recirculated air is at cabin temperature plus blower rise.

To protect against improper 160°F temperature sensing at low altitudes when both doors are open, the engine bleed air supply is shut off during the condition when both doors are open. This is accomplished by automatically closing the modulation valve. In addition check valves are included in the outside defrost lines to prevent reverse flow during doors-open operation. Reverse flow would occur only when ram pressure rise exceeds cabin to atmosphere pressure differential, principally at low altitude or during unpressurized flight.

The heated air defrosting system may be considered as a combined "inside" and "outside" system. The "inside" heated air passes over the inner surfaces of the two scan windows and the nose cover window. The "outside" heated air passes over the outer surfaces of the windows covered by camera window doors. This air must necessarily pass from the pressurized compartment to the unpressurized space between the camera windows and the cover doors. Additional kinetic energy over that supplied by the blower and the engine bleed air is supplied to the outside defrosting air due to cabin pressure differential above 5000 feet altitude. This additional energy aids in maintaining a high velocity of defrosting air over the outside surfaces of the nose camera and viewfinder windows. A venturi is placed in the duct supplying these two windows to limit the flow of air from the pressurized compartment. The venturi was selected as a flow limiter because of its low pressure head loss characteristics which is desirable at low altitudes when the cabin pressure differential is low or zero. The defrosting air, after passing over the outer surfaces of the two windows, is exhausted overboard.

An ON-OFF valve is located at the navigator's station in the inside heated air duct supplying the scan and nose cover windows in order that this heated air being dumped into the compartment may be shut off when undesired. This valve does not stop the flow of heated air passing through the venturi to the outside defrosting system of the nose camera and view-finder windows.

An overheat thermal switch set at 190°F is located in the defrosting mixed air (160°F) duct to provide protection on overheat conditions. Actuation of this switch on overheat will close the safety valve in the engine bleed line and will actuate the "Defrost Failure" light on the navigator's control panel. Another overheat thermal switch, set at 190°F, is located on the outlet of the blower. If there should be hot air reverse flow through the blower (blower failure), actuation of this thermal switch closes the safety valve and lights the "Defrost Failure" light at the navigator's station.

It should be noted that the navigator's compartment defrost system configuration tested in RB-47E airplane AF 51-5258 is completely representative of the first 16 production RB-47E airplanes (S/N 51-5258 through 51-5273) and basically represents all RB-47E configurations. The navigator's compartment defrost system of airplanes S/N 51-5274 and on differ from the test configuration in that the defrosting lines to the scan windows have been increased from 0.5" Dia. (BAC drawing 5-48685) to 0.75" Dia. (BAC drawing 5-54189). In addition beginning with unit 115, S/N 52-747, and on a shutoff valve has been added upstream of the flow limiting venturi to prevent loss of cabin air overboard during pressurized flight when the defrost system is turned off.

B. <u>Cabin Air Conditioning System</u>

The cabin air conditioning system installed in RB-47E airplane AF-51-5258 is a modification of the production system for the first 194 RB-47E airplanes, S/N 51-5258 through 52-781, in that a moisture separator installation with an experimental 35°F control system was installed. The cabin air conditioning system including the moisture separator installation with the experimental control system is shown schematically in Figure 2A. The moisture separator installation configuration is identical to BAC Drawing 5-60798, Reference 5, with exception of the 35°F control system and the moisture separator by-pass valve. The 35°F control system was an electronic type instead of the pneumatic type shown on BAC Drawing 5-60798, Reference 5. This electronic control system consisted of a BAC Specification 10-1078 electrically operated valve for use as the turbine by-pass modulating valve, an AiResearch 33500-10. 35°F temperature sensor, and an AiResearch 30058-17 electronic temperature regulator. The function of these components of the electronic water separator temperature control is to by-pass a sufficient quantity of warm bleed air from downstream of the cooling unit heat exchanger and mix it with the turbine discharge cold air so as to maintain a package discharge temperature of 35 ± 2°F at all airplane altitudes from sea level

to approximately 25,000 feet.

The Boeing 9-43699 water separator by-pass valve assembly, Reference 6, as used in the flight test airplane, was modified to include an experimental Boeing-designed aluminum actuating piston with an "O"-ring pressure seal. This piston configuration replaced the Teflon piston originally installed in this valve. The function of this valve is to by-pass the cooling unit discharge air around the moisture separator at airplane altitudes above 25,000 feet or whenever a pressure differential across the moisture separator is reached above which possible damage to the separator and/or duct system could occur.

The RB-47E cabin air conditioning system in general was the same, component and operational-wise, as that of the B-47E airplanes prior to the installation of ECP 1271 and ECP 1855-2. Consequently, the navigator's air outlets and selector valve were not revised nor was the 1500-watt electrical heater in the lower outlet or the navigator's insulated floor installed. However, these changes will eventually be incorporated on all RB-47E airplanes (unit 1 through 240).

FLIGHT TEST INSTRUMENTATION CONFIGURATION

The navigator's compartment defrost system was instrumented according to the Flight Test Outline (Reference 4) and the location of instrumentation is shown schematically in Figure 1. Complete details such as specific locations, type of pickups and indicating instruments are given in Flight Test Instrumentation Document WD-13563, Insert 1, and Figures 41 through 53. In general, however, all flow measurements were based on indicated static and velocity pressures. Static pressures were measured by Prandtl type pickups and velocity pressures were obtained by the differential between a Prandtl static tube and a venturi-type total pressure pickup. Pressures, airspeed, engine RPM, voltage, amperes, valve position, etc., were recorded simultaneously by a photorecorder which was set at a predetermined frequency. The temperatures (thermocouple-type pickups) were recorded on a Brown recorder on a one-per-second cycling basis.

The location of the temperature instrumentation on the window surfaces is shown in Figures 46, 49, 52 and 53. The wall temperature thermocouple locations are shown in Figures 47, 48, 50 and 51. Duct line and miscellaneous pressure and temperature instrumentation locations are shown in Figures 41 to 45 inclusive. Additional details covering the remaining flight test instrumentation are included in Insert 1.

Navigator's compartment humidity was measured by a fan-type psychrometer and recorded by oscillograph. The psychrometer is shown in BW-104104, Insert 1, at its location in the navigator's compartment. The general configuration of the psychrometer is shown in WD-12829, pages 150-2 and 150-7, Insert 3.

A-4 Cameras were located and focused on the window surfaces in order to obtain photographs of the windows when fogging and frosting was anticipated or observed.

A calibration curve of the outside defrost venturi is contained in this report as Insert 4.

SYSTEM PERFORMANCE REQUIREMENTS

The navigator's compartment defrosting was designed so that the provision for defrosting the camera and viewfinder windows will fulfill the requirements of MIL-T-5842A (Reference 1). All other windows in the navigator's compartment were designed somewhat marginal in terms of MIL-T-5842A. The basic requirements are as follows:

1. The system must be capable of providing frost and fog-free surfaces during steady state conditions.

2. The system must be capable of providing frost and fog-free surfaces during transient state conditions.

The surfaces are maintained frost and fog-free by keeping the surface temperatures above the dew-point temperature of the surrounding air. Figure 3 shows the ambient temperature variation with altitude for the transient and steady state specified in MIL-T-5842A. The ambient air is considered 100% saturated at all altitudes and temperatures and therefore, the curve in Figure 3 also represents the ambient dew-point temperature curve. At altitudes in excess of 35,000 feet, the moisture separator is inoperative and consequently the cabin compartment dew-point will be greater than ambient due to the moisture added by the crew members, which is to be considered as 0.5 lbs of H_2O per hour per occupant, as specified in MIL-T-5842A. The defrost system analysis, D-12207, does not specify a design dew point for the cabin but instead provides for a window surface temperature of 10°F.

The operational requirements set forth in Reference 1 are as follows:

1. The defrosting and defogging system shall be effective during all conditions of flight, including the following:

   (a) During flight at constant altitudes under the steady state atmospheric conditions shown in Figure 3.

   (b) During a rapid descent from altitude (maximum rate of descent at limit dive speed from service ceiling to sea level and rate of descent at recommended descent speed) under the atmospheric conditions of the transient temperature variation as shown in Figure 3.

Military Specification MIL-T-5842A does not specify operational or environmental requirements for ground operation of the defrost system. However, it is desirable to have clear camera window surfaces at take-off time, but probably not absolutely essential because there would be considerable time from take-off to usage for clearing to occur. It will be attempted to show what ground defrosting protection is available during environmental condition of the transient day at sea level, that is, when the ambient temperature is 85°F and the air is 100% saturated.

PLAN OF TESTS

The Navigator's Compartment Defrosting System flight test portion of the WFT-709B program was planned to provide:

1. Ground checks of the navigator's compartment defrost system and components functional-wise and recorded system ground performance.

2. Flight evaluation of the navigator's defrosting system operational-wise and recorded system performance during two typical RB photo-reconnaissance missions:

   (a) High altitude Photo-Reconnaissance consisting of a normal rated constant RPM (96%) climb from base altitude to cruise altitude; cruise climb (Mach .74) for several hours to target area and a 25-minute combat cruise over target at approximately 40,000 Ft. during which time the camera doors are opened for the last 25 minutes only.

   (b) Low altitude Photo-Reconnaissance consisting of a normal rated constant RPM (96%) climb from base altitude to cruise altitude; cruise climb (Mach .74) for several hours to target area; maximum rate, minimum idle, gear down descent to 1000 Ft. above target area (sea level target) and a maximum speed (placard 425 knots) 30 minute dash over target with camera doors open during the first 25 minutes of the dash only.

In order to complete both typical missions on one test flight the flight profile was planned as shown in Figure 4. The flight from "Take off" to the end of the 1,000 Ft. dash represents the low altitude Photo Reconnaissance mission while the remainder of the flight beginning with the climb from 1,000 Ft. to cruise altitude represents the High Altitude Photo Reconnaissance mission.

The RB-47E Defrost System Test Program, WFT-709, consisted of the following tests:

TEST	DATE	TYPE	REMARKS
5-3	12-30-53	Ground Test	Cabin and Camera Compartment defrosting system check
5-4	1-4-54	Ground Test	Cabin and Camera Compartment defrosting system check

6-1	1-22-54	Check Out Flight	Cabin and Camera Compartment Instrumentation Check Out and Airplane check out flight
9-1	3-9-54	Flight Test	Cabin and Camera Compartment Defrosting System test
9-2	4-27-54	Flight Test	Cabin and Camera Compartment Defrosting System test
9-3	4-29-54	Flight Test	Cabin and Camera Compartment Defrosting System Test aborted due to malfunction of cabin air conditioning system
9-4	5-4-54	Flight Test	Cabin and Camera Compartment Defrosting System test

Figures 4, 6 and 8 show profiles of flights 9-1, 9-2 and 9-4, and indicate what airplane configurations were checked during each flight condition. Flight 9-3 was an aborted flight and is therefore not included.

Flights 9-2 and 9-4 were repetition of flight 9-1 and were conducted in an attempt to accomplish all the conditions of the "Plan of Test" 9-1, Insert 2, without airplane, equipment, or instrumentation malfunction.

OUTLINE OF FLIGHT AND GROUND TESTS

Reference 4, "Outline for Flight Test WFT-709" specifies the flight and ground test procedure and requested the following data:

1. Atmospheric conditions in vicinity of flight test.
2. Cabin pressure (altitude).
3. Temperatures and pressures per instrumentation shown in Figure 1.
4. Engine power settings.
5. Cabin humidity.
6. Voltage and current for the nose defrost blower.
7. Indicated airspeed.
8. Pictures of windows during flight.
9. Crew comments on system operation.
10. Modulation valve and defrost check valve position.

A. GROUND TESTS

The purpose of the ground tests was to (1) functional check the system in accordance with Section 06.1500 of Boeing document D-9700 - Functional Test Requirements and Procedures (B-47) and (2) check ground operation performance of the system. The detailed plans are given in Reference (4) but basically the ground test consisted of:

1. System stabilization time at 75% RPM (25 to 30 psi bleed air pressure).
2. Check of reverse flow through blower.
3. System stabilization time at 96% RPM (approximately 50 psi bleed pressure).
4. Check of the effect of transient engine power changes on the defrost system.

B. FLIGHT TESTS

The purpose of the flight tests was to verify the navigator's compartment defrost system performance during high altitude steady state and

transient state environmental conditions as required per MIL-T-5842A. These conditions are the most critical from the standpoint of system performance. The original flight test plan was to simulate a high altitude photo mission first and then simulate a low altitude high speed photo mission. However, the flight test plan as outlined in Reference 4 and as presented in "Plan of Test" 9-1 of insert 2, was altered somewhat because at the time of test, weather conditions in the Wichita area were not conducive to frosting so the following secondary plan was used:

1. Climb to maximum range cruise altitude at normal rated climb with camera window cover doors closed.

2. Maximum range cruise condition (cruise climb 88% RPM Mach .74).

   (a) Cold soak for approximately one and one-half hours after leveling off at cruise altitude.

3. Maximum rate "gear down" minimum idle descent to approximately 1,000 feet above surrounding terrain with all doors closed.

4. Maximum speed dash at 425 knots IAS at 1,000 feet above terrain for approximately twenty-five minutes.

   (a) Camera window doors open for first fifteen minutes of maximum speed dash.

   (b) Camera doors closed for remaining ten minutes of low altitude dash.

5. Normal rated climb to cruise altitude. Approximately one and one-half hours after reaching cruise altitude, open doors for twenty-five minutes to simulate high altitude photo mission.

6. Descent for landing.

Actual flight profiles accomplished according to the secondary plan are shown in Figures 4, 6, and 8.

DESCRIPTION OF ACTUAL GROUND TESTS

Test 5-3

This test was aborted because of a camera compartment overheat indication during the transient power change condition.

Test 5-4

The navigator's compartment defrost system was ground tested according to paragraph C-1 of the Flight Test Outline, Reference 4, and was recorded as test 5-4 on 4 January 1954. The OAT during the test was 53 ± 3°F. A detailed plan of test is given in Insert 2 - Test No. 5.

The system was functional tested in accordance with Section 06.1500 of Boeing Document D-9700 to insure satisfactory operation of system components.

The actual ground test was run according to plan except as noted in the following paragraph. Engine #3 was operated at approximately 75% RPM to maintain an engine bleed pressure of 25-30 psi. The time for stabilization of mixed air temperature was recorded. Reverse flow through the blower was checked by observation. The engine RPM was increased to approximately 96% RPM or an engine bleed pressure of 60 psi. The effect of transient engine power change on the defrost system and mixed air temperature stabilization time was noted. The engine RPM was maintained at 96% for 15 minutes. The cabin air conditioning system was operative and maintained the cabin temperature at approximately 80°F during the test.

In the process of evaluation of the final ground and flight test data it was revealed that the nose camera and viewfinder window cover doors were inadvertently opened during ground test 5-4. A simultaneous malfunction of the navigator's defrosting system electrical control system permitted the modulation valve to remain open and modulate instead of closing as designed. The apparent malfunction could be attributed to deficient limit switches in the cover doors circuit. However, since this malfunction was not evident until after the completion of the flight test program no investigation of this matter during the testing period was accomplished. This matter is discussed later in the report.

DESCRIPTION OF ACTUAL FLIGHT TESTS

A. Test 9-1

This test was conducted on 9 March 1954. The Gulf Coast region between Louisiana and Texas had weather conditions conducive to frosting so the maximum rate descent and subsequent high speed dash were made in the vicinity of Lake Charles, Louisiana.

1. Test Environmental Conditions:

   Ambient temperature and relative humidity variation with altitude at Lake Charles is shown in Figure 4. The ambient temperature variation, as compared to a design day per MIL-T-5842A, is shown in Figure 10. This information is based on Radiosonde data from the USAF Weather Station at Lake Charles, Louisiana.

2. Performance of Test:

   Reference 7, Flight Test Activities Report gives a detailed description of the test. Except for the following, the flight was basically accomplished per Insert 2 - Test No. 9, and the deviation noted in the "Outline of Flight and Ground Tests" section of this document.

   (a) The high speed dash at low altitude was delayed approximately 10 minutes due to a malfunction in the forward landing gear retraction mechanism. The flight profile is shown in Figure 4.

3. Data Obtained:

   The bar graph in Figure 5 gives the data recorded versus time. Photographs of the nose camera window during the simulated high altitude photo mission were not taken because the time delay in trying to retract the gear at low altitude was of sufficient duration to use all the film. The pictures that were taken at low altitude were not of sufficient quality that would enable determination of frost or fog and therefore are not contained herein.

   Boeing Document WD-13564, "Flight Test, Plans, Conferences and Data" contains the tabulated temperature and pressure data as well as a record of the post flight conference.

B. Test 9-2

This test was conducted on 27 April 1954 in a region of high humidity

near Galveston, Texas. The maximum rate descent was made in the Corpus Christi and Galveston vicinity but is referred to as the descent at Corpus Christi since Radiosonde data was obtained from this station.

1. Test Environmental Conditions:

Radiosonde data for several stations along the flight profile are shown in Figure 6 and it can be noted that humidity conditions in the descent region are quite high. Figure 10 is a comparison of the test ambient condition to the design day of MIL-T-5842A.

2. Performance of Test:

A detailed description of the test is contained in Flight Test Activity Report, Reference 7. Due to a malfunction of the gear retracting mechanism the low altitude, high speed dash was aborted as shown in Figure 6. However, the high altitude photo-mission was simulated as shown in Figure 6.

3. Data Obtained:

Figure 7 shows the time and type of data obtained during test 9-2. Due to a malfunction of the forward oblique camera, pictures of the nose window are not available.

C. Test 9-3

1. Performance of Test:

This flight was aborted during the initial high altitude cold soak due to a malfunction in the cabin air conditioning system. Details concerning operation of the air conditioning system are presented on Page 23 of Boeing Document WD-13400-29 "Flight Test Activities Report" Reference 8.

2. Data Obtained:

No useful Defrosting System data was recorded.

D. Test 9-4

The descent for the final defrost test was made near Tampa, Florida in a region of ambient conditions conducive to frost or fog. The flight pattern is shown on Page 23 of Reference 7, "Flight Test Activities Report", WD-13400-41. The flight profile is shown in Figure 8.

1. Test Environmental Conditions:

Radiosonde ambient conditions from the USAF Weather Stations along the flight path are shown in Figure 8. The relative humidity is quite high at the altitude at which the high speed dash was conducted. Figure 10 shows the comparison of test and design day ambient conditions for the descent.

2. Performance of Test:

Details of the test are in the "Flight Test Activity Report", WD-13400-41, Reference 7. Except for the following, the flight was basically accomplished per Insert 2 - Test No. 9, and the deviation noted in the "Outline of Flight and Ground Tests" section of this document:

(a) The water separator was inadvertently left in the OFF position during the entire flight.

(b) The camera doors were closed for the first ten minutes of the maximum speed low altitude dash and open for the last fifteen minutes.

3. Data Obtained:

The data recorded during the test is shown in Figure 9. Due to a malfunction of the Brown recorder only a limited amount of temperature data is available for the cabin. Malfunction of the A-4 Camera prevented taking any pictures of the nose camera window.

A tabulation of data recorded plus a record of the post flight conference is contained in Boeing Document WD-13564, "Flight Test Plans, Conferences and Data".

EVALUATION OF RESULTS

A. Ground Tests

The ground test outline specifies that the defrost system operation was to be checked with the cover doors closed. Although the doors were inadvertently left open during the test an apparent malfunction of the system allowed the modulation valve to open or cycle when it should have been closed.

The more significant results of ground test 5-4 are shown in Figure 11. The results of the ground test may be somewhat inconclusive in that it appears insufficient time was allowed for system stabilization at 74% and 96% RPM. The defrost mixed air temperature did not stabilize during either of the 15 minute runs at constant power settings. At 74% RPM the mixed air reached a temperature of 129°F, dropped to 127°F, and returned to 129°F in a period of 3 minutes. However, approximately 8 minutes later the mixed air is approximately 135°F and still rising even though the engine RPM is still 74%. At 96% RPM the mixed air reached a high of 159°F and as indicated the modulation valve started to cycle and the mixed air temperature was lowered. However, after approximately 8 minutes the mixed air temperature was 152°F and did not come into the control band of 160 ± 5°F after 3 more minutes of operation at 96% RPM. Of more significance is the fact that after reaching a temperature of 159°F the mixed air temperature steadily declined and after approximately 10 minutes the high was only 154°F even though the engine RPM was maintained at approximately 96%. The reason for this temperature decline can be attributed to the fact that the modulation valve "stabilized" at approximately half open instead of opening further as demanded by the decrease in mixed air temperature.

The nose defrost system design is such that the modulating valve will automatically close when both cover doors are open (camera and viewfinder). However, as noted in Figure 11, the modulating valve was not closed when the doors were open. This apparent malfunction is believed to result from deficient limit switches. At any rate, the system did not perform satisfactorily during this ground test. However, no adverse hunting of the modulation valve or instability of the temperature control system was evident during or as the result of either transient or constant power conditions. Some slight modulation of the bleed air modulation valve occurred for approximately 3 minutes following the power change from 74% to 95%, Reference Figure 11.

No reverse flow through the defrost blower was observed at any time during the ground tests.

Since the viewfinder and nose camera doors were inadvertently left open, the resulting window surface temperatures are not indicative of those to be expected during normal ground operations with the cover doors closed. Therefore, no evaluation of ground frosting protection can be made for the view finder and camera windows. As far as the windows that do not have covers at any time and are defrosted by air over the inside of the glass are concerned, it can be seen from Figure 11A that the average temperature of the nose cover window and both scan windows was approximately 75°F with an OAT of approximately 53°F. Therefore, it is reasonable to expect that on a design day of 85°F the window surface temperatures will be in excess of 85°F which

is the design temperature per MIL-T-5842A.

B. FLIGHT TESTS

1. Effect of variables on System Performance

The flight tests were not conducted in environmental conditions as specified in MIL-T-5842A, Reference 1, and therefore, these differences must be examined to determine the effect on system performance. In addition, the airplane was not flown in accordance with design condition of speed, power setting, etc.

The differences between test and design that could affect system performance are as follows:

(a) The effect of ambient temperature on temperature distribution through camera windows.

(b) The effect of airspeed, power setting and indicated OAT on bleed air temperature.

(c) The effect of rate of descent upon glass surface temperature change during descent.

(d) The effect of ambient moisture content on cabin dew-point temperature.

A discussion of the first three variables is contained in Reference 11, WD-14016, "Analysis of the WFT 709 Flight Test of the RB-47E Camera Compartment Defrosting System". The navigator and camera compartment defrost system tests were conducted simultaneously and therefore only the conclusions from Reference 11 will be given here: "In concluding the discussion of the variables that might affect the performance of the system it can be said that although there were in some cases a considerable difference between test and design conditions, these differences are not expected to cause much of a change in inside surface temperature. Therefore, the flight tests could be considered typical of design as far as the glass surface temperatures obtained throughout the descent are concerned". Figure 12, 13 and 14 show the indicated OAT during descent, descent speeds and descent time obtained during the flight tests versus design.

A discussion of the fourth variable, ambient moisture content, follows: The compartment wet bulb and dry bulb temperatures were measured during the flight test with the intent of determining the compartment dew point. However, the data obtained has been proved unreliable. The instruments used would not accurately measure wet bulb temperatures below 32°F and, in addition, pressure or altitude variations produced erratic results. The flight test analysis of the camera compartment defrost system, WD-14016, Reference 11, presents a very detailed explanation of the humidity instrumentation discrepancies and limitations, which were substantiated by extensive laboratory testing.

Since the humidity data could not be used, a method of estimating the approximate compartment dew point was determined, as shown in Supplement A. The defrost specification MIL-T-5842A, Reference 1, requires that the moisture added by crew members in an occupied compartment be based on 0.4 lbs/hr. per occupant. The water separator

is inoperative above 25,000 feet so the moisture content above this altitude can be considered ambient or approximately 2 grains/lb dry air, plus that added by the crew members. To determine the specific moisture content of the cabin air, the cabin ventilation rate must be known. However, since the ventilation rate was not measured in the defrosting tests, the maximum flow through the flow control valve was used to determine the dew point, based on the maximum air flow into the cabin. Using the maximum flow rate, the calculated compartment dew point at approximately 39,000 feet was approximately -5°F. However, the moisture addition by crew members in MIL-T-5842A was perhaps based on a 75°F environmental temperature. Since the navigator's compartment temperature was approximately 40°F during high altitude it is believed that a more realistic figure for moisture addition would be approximately 900 grains/hr instead of 3500 grains/hr, as shown on Page 122 of the 1955 Edition of The Heating, Ventilating, Air Conditioning Guide (Reference 10). The calculated compartment dew point using this revised moisture addition and maximum ventilation rate was approximately -9°F at 39,000 feet.

The above approach is most optimistic, so the dew point was determined by using the minimum airflow required to maintain cabin pressurization at the altitude under consideration. The calculated dew point for moisture addition based on MIL-T-5842A was approximately 11°F and based on the revised moisture addition the dew point was approximately 7°F.

The following is a tabulation of the calculated cabin compartment dew point for a steady state flight at 39,000 feet, (Supplement A).

DEW POINT TEMPERATURE	VENTILATION RATE	MOISTURE ADDITION BASED ON
-5	Maximum	MIL-T-5842A
-9	Maximum	Cold Compartment
11	Minimum	MIL-T-5842A
7	Minimum	Cold Compartment

It can be seen that the window surface temperature must be 11°F or above for maximum defrost protection during a high altitude photo mission (camera doors open). The design inside surface temperature for the nose camera and viewfinder windows is 10°F as shown in the design analysis D-12207 (Reference 2).

2. System Performance

(a) Window Surface Temperature

(1) High Altitude Photo Run, Camera Doors Open

The design inside window surface temperature vs. the lowest measured values during the simulated high altitude photo missions are tabulated below as shown on Figures 22, 23, 24 and 25.

WINDOW	DESIGN	INSIDE SURFACE TEMPERATURE °F Test 9-1	Test 9-2
Nose Camera	10	-1	0
Viewfinder	10	-4	-6
Nose Cover		12	17
R.H. Scan		10	14
L.H. Scan		17	22

The nose camera and viewfinder window inside surface temperatures are deficient in comparison to design. A design inside surface temperature was not stipulated for the nose cover and scan windows in the original design analysis D-12207 (Reference 2). However, as can be noted, the nose cover and scan window surface temperatures are at or above the design surface temperature for the nose camera and viewfinder window. Referring to Figures 24 and 25 it can be noted that a difference of approximately 40°F exists between the mixed air temperatures for test 9-1 and 9-2 (the modulating valve closed when the cover doors were open for test 9-2 and consequently the mixed air temperature decreased). It is noted that the nose cover and scan window surface temperatures were slightly lower, approximately 5°F, during test 9-1 than during test 9-2. This is pointed out since the mixed air temperatures during 9-1 were considerably higher than during 9-2. In view of this, all other variables affecting these surface temperatures were evaluated as data permitted. However, due to the nonexistence of air flow data to these windows and the correlation limitations of other flight test data the reason for the possible discrepencies in surface temperatures could not be fully determined.

As shown in Paragraph B-1 of "Evaluation of Results" the calculated compartment dew point varied from +11 °F to -9°F. It would appear that the nose camera and viewfinder windows should frost during a high altitude photographic reconnaissance mission. However, it will be revealed in subsequent discussion that all windows were reported clear. Never-the-less, the defrost system is considered marginal during a high altitude photo mission since the window surface temperatures were so low.

(2) Steady State Maximum Range Cruise Camera Doors Closed

The following tabulation gives the design inside window surface temperature and the lowest surface temperature measured just prior to the initial descent as shown in Figures 15, 16, 19, 20 and 21.

WINDOW	INSIDE SURFACE TEMPERATURE °F		
	Design D-12207	Test 9-1	Test 9-2
Nose Camera	80	41	37
View Finder	80	46	45
Nose Cover	20	28	34
R.H. Scan	20	22	26
L.H. Scan	20	24	24

The design values are for an altitude of 45,000 feet while Test 9-1 was at approximately 35,000 feet and Test 9-2 was at approximately 37,000 feet.

The following tabulation gives the inside surface temperatures just prior to opening the camera doors during the high altitude photo run at approximately 39,000 feet as shown in Figures 22, 23, 24 and 25.

WINDOW	INSIDE SURFACE TEMPERATURE °F	
	Test 9-1	Test 9-2
Nose Camera	32	33
Viewfinder	39	34
Nose Cover	16	23
R.H. Scan	10	16
L.H. Scan	23	22

All the temperatures are considerably lower at this altitude as compared to the previous tabulation of temperatures at 35,000 feet and 37,000 feet.

In both cruise conditions for the same flight the nose camera and viewfinder windows are deficient from a standpoint of surface temperature at high altitude. It is also apparent that all other windows are either marginal or deficient at 45,000 Ft. in terms of the design criteria.

(b) Mixed Air Temperature

The nose compartment outside defrost system was designed for a mixed air temperature at the defrost outlet of 160°F. The mixed air temperature at the defrost outlet obtained in the Flight Tests was approximately 50% of the design value. The mixed air temperature just upstream of the venturi before, during, and following the low level high speed dash for test 9-1 and 9-2 is shown in Figure 17. The several factors that resulted in the deficient

air temperature will be discussed separately. Due to the incomplete airflow instrumentation in the nose compartment, the mixing ratio of bleed air to blower air could not be determined.

(1) Bleed Air Temperature

The original design analysis D-12207 does not specify an expected or design bleed air temperature at the mixing duct. Although the engine bleed port air temperature was not measured in these tests it is believed this temperature was design or better, based on test data for similar days. The temperature drop from the bleed port to the defrosting takeoff duct (Figure 1, T/C 46) is estimated to be approximately 60°F as compared to the original assumed drop of 35°F, used in D-12207, Reference (2).

The bleed air temperature drop from upstream of the modulating valve to just upstream of the mixing duct is shown in Figure 18. This temperature drop is approximately 85°F for Test 9-1, and approximately 90°F for Test 9-2, during the maximum range cruise just prior to the initial descent. These temperature drops are approximately 30 percent greater than the anticipated temperature drop as shown on the curve on Page 32 of T-28288, Reference (3), "Performance Test of Crew Compartment Defrosting System". Using 230 °F for Test 9-1 and 240°F for Test 9-2, from Figure 18 and referring to the curve of T-28288, Reference (3), the temperature drops should have been approximately 64°F and 70°F respectively, which would have given a bleed air temperature into the mixing duct of 166°F for 9-1 and 170°F for 9-2.

The curves on Figure 22 and 23 show a greater drop in bleed air temperature during the high altitude photo run. A typical example from Figure 22 is a bleed air temperature upstream of the modulating valve of 214 °F and upstream of the mixing duct a temperature of 130°F, or a drop of 84°F during Test 9-1. Figure 23 shows a temperature drop from 226°F to 129°F or 97°F during Test 9-2.

(2) Compartment Temperature

The design analysis D-12207 assumed the navigator's compartment temperature to be uniform at 70°F. However, as shown on Figure 26, the maximum temperature during the maximum range cruise condition at approximately 36,000 feet was only 53°F at the navigator's head level and at the same time the minimum was approximately 40°F in the vicinity of the viewfinder window, for Test 9-1. For Test 9-2, during the maximum range cruise condition at approximately 37,000 feet, the maximum was 38°F. Those temperatures are indicative of the compartment

temperature obtained for the RB-47E since similar gradients were encountered in the Air Conditioning Flight Test, WFT-708. WD-14014, Reference 12, reports that the compartment temperature in the area of the nose camera window was less than 30°F at an altitude of approximately 40,000 feet.

(3) Mixed Air Temperature Drop

The mixed air temperature drop from the temperature control sensing point to just downstream of the defrost check valves is shown in Figure 15 and 16 during the maximum range cruise prior to the initial descent.

The total temperature drop in the two duct systems is approximately equal to 20°F. This temperature drop is excessive and is perhaps the result of leakage around the 9-30139 transition assembly and the 6-43907 air check valves. These two components of the duct system are downstream of the venturi and therefore cabin pressure differential exists across these parts. Leakage would allow cabin air to leak into the duct system and consequently lower the mixed air temperature. The laboratory test of the nose defrost system as reported in T-28288 revealed this leakage problem and recommended the necessary design changes.

(c) Recirculated Cabin Inside Defrost Air Temperature

The navigator's compartment defrost system was originally designed to have "inside defrosting" as shown in Reference (2) D-12207, only when both camera doors were open or when the camera ventilation valve was actuated by the camera overheat thermal switch. However, based on the results of Reference (3) T-28288, the camera ventilation valve was removed since blower operation was unstable when the valve was closed. Therefore, the system as flight tested was essentially a combination "inside" and "outside" defrost system since airflow was directed over both sides of the nose camera and viewfinder windows. The "inside defrosting" and camera ventilation air temperatures before, during, and following the low level high speed dash for tests 9-1 and 9-2 are shown in Figure 27.

The "inside defrosting" and camera ventilation system is believed to be detrimental to the overall navigator's compartment defrost system performance, especially during high altitude flight when the average cabin temperature is approximately 40°F. However, with a compartment environmental temperature of 70°F or above, the recirculated defrosting air is desirable, due to the higher dew point temperature in an occupied compartment and also due to the limited defrosting, when either or both the camera and viewfinder door are open. A slight increase in window surface temperature may be obtained since the higher velocity of the recirculated air will result in a greater film coefficient as compared to stagnant or still air.

(d) System Airflow

(1) Venturi and Bleed Airflow

The venturi and bleed airflow are approximately equal during a steady state high altitude condition as evidenced by Figures 28 through 31. The bleed air-flow during descent and low altitude flight cannot be determined because of the type of flow instrumentation used, but it can be noted that the modulating valve did not close at all times when the camera doors were opened, as shown in Figure 28, 30 and 32 which are for tests 9-1 and 9-4. However, as shown on Figure 31 the modulation valve closed when the doors were open for the high altitude photo run of test 9-2, and the modulating valve also closed during the high altitude photo run of test 9-4. Airflow data could not be determined during the high altitude photo run of test 9-4 because of a temperature recorder malfunction and consequently, modulating valve position was not plotted. Also, as can be noted in Figure 31, sufficient data was not obtained to allow a check of the modulating valve opening and closing time. It is also noted that the modulating valve cycling did not at any time go below 9.5° or approximately half closed. However, this could be contributed to the inadequacy of the instrument used to record the valve position.

(2) Defrost Airflow from tests 8-3 and 8-4 (WFT-708)

Test data for the navigator's compartment defrosting system was also obtained during certain tests of WFT-708 "Camera Compartment Air Conditioning Flight Test of RB-47E, AF51-5258" During test 8-3, counter numbers 2867 to 4867, Figure 34, the bleed airflow was measured with the navigator's manual shutoff valve in the "OFF" position. The bleed airflow was also checked during test 8-4, counter numbers 10649 to 12599, Figure 34 with the manual shutoff valve in the "ON" position.

The bleed airflow with the navigator's manual valve in the "OFF" position was approximately 1.40 lbs/min and with the valve "ON" the airflow was approximately 1.36 lbs/min., therefore, it can be concluded that the valve position has little effect on bleed air. The bleed air temperatures at the mixing duct were approximately the same as those obtained in WFT-709 test 9-1. The bleed air temperature drop from the defrost duct takeoff to the mixing duct was approximately 87°F for 8-3 and approximately 100°F for 8-4.

The temperature drop for 8-3 is within the range for 9-1 and 9-2 but the temperature drop for 8-4 is approximately

100°F. The extra temperature drop for 8-4 may be explained by the decrease in airflow.

The necessary pressures for measuring flow through the venturi in tests 8-3 and 8-4 were obtained but unfortunately the mixed air temperature is unavailable. However, based on the pressures, the venturi flow can be estimated to be approximately comparable to that obtained in tests 9-1 and 9-2.

The lack of mixed air temperature for the above eliminates determination of the outside defrost air temperature that could be expected with the navigator's manual valve in the "OFF" position.

(3) Blower Airflow

The blower airflow for the three tests 9-1, 9-2, and 9-4 is shown on Figures 33 through 37. The airflow was determined for the steady state conditions of each test for which data was available. Test 9-1 is the only test which had complete data for the maximum range cruise, low altitude high speed dash, and high altitude photo run. Test 9-2 data was available for only the high altitude photo run, test 9-4 data was available for only the low altitude high speed dash.

The blower airflow at altitude for test 9-1 averaged about 9.5 lbs/min at 27 volts and 18.5 amps as noted in Figures 33 and 35. During the high altitude photo run of test 9-2 the airflow was approximately 11 lbs/min, as shown in Figure 36, but this could be explained by the fact that the voltage is 28 and the current is approximately 21 amps. Figures 34 and 37 show the airflow for the low altitude high speed dash during test 9-1 and 9-4. The blower operation is quite erratic for both tests but 9-4 shows the more pronounced fluctuation. The apparent erratic operation of the blower is believed to result from the fluctuating bleed airflow which is shown in Figures 28 and 32. The method of determining the blower airflow may also be a contributing factor to the apparent erratic airflow. Since the total system airflow was not measured, the blower airflow was estimated by means of relationship of blower output to input current. This also explains the reason for the similarity between the blower airflow and the current curves in Figures 34 and 37.

(e) Temperature Control Sensor

The temperature control maintained the mixed air temperature

at a maximum of 170°F during test 9-1, and a maximum of 166°F during test 9-4 as shown in Figure 38. The control setting of 160 ± 5°F is exceeded but only by a slight margin and is considered to have operated satisfactorily. The system design is such that the modulating valve is supposed to close when the cover doors are open. However, the modulating valve did not close but cycled or "hunted". This cycling or "hunting" is attributed to a malfunction of the cover door limit switches and accounts for the temperature control system fluctuation noticeable during test 9-4.

(f) Window Frosting and/or Fogging

An attempt to photograph windows that had frost and/or fog was unsuccessful since any condensation was not visible or readily distinguishable as such on the finished prints. Therefore, the flight test crew's comments during the post flight conferences are the only tangible evidence available as to window frosting or fogging during the tests.

(1) Test 9-1

The initial maximum rate descent was made southwest of Lake Charles, Louisiana. The pilot, copilot, and navigator did not observe or could not be sure of any condensation on any window during the letdown or during the maximum speed run. The dew-point temperature at Lake Charles at the time of flight was 69°F. A malfunction of the gear retracting system necessitated a ten-minute period of "jockeying" the throttles at the low altitude before beginning the maximum speed dash. This could have a bearing on why no condensation was readily observable even though the lowest camera or viewfinder window surface temperature at the end of the descent was approximately 45°F and the highest was only 55°F. After a ten-minute low speed flight, the lowest inside window surface temperature was 62°F (R. H. Scan Window at 1/2 throw), as shown on Figure 20. The nose camera and viewfinder windows had an inside surface temperature of 69°F after the ten-minute dash. If the maximum speed dash would have been initiated right after the descent, a much greater amount of moist air would have been forced into the cabin and window fogging could very well have occurred.

During the climb to altitude and the high altitude photo run after a period of stabilized flight, no condensation was reported on any windows.

(2) Test 9-2

The maximum rate descent was made over the Gulf of Mexico just southwest of Galveston, Texas into an atmosphere with 71°F dew point temperature. However, the maximum speed dash had to be aborted due to gear malfunction. The pilot reported fogging on both sides of the canopy and very light frost on the right side of the windshield panel. The copilot reported fogging but not to the extent that was reported by the pilot. The navigator reported rather heavy fogging on both scan windows during the descent. The navigator did not report any condensation on the nose camera, nose cover, or viewfinder windows during the descent. The crew did not report any condensation on any windows during the High Altitude Photo Run.

(3) Test 9-4

The maximum rate descent was made over Tampa, Florida where a dew point of approximately 70°F existed. The water separator was inadvertently left in the off position during the entire test and, therefore, the test conditions at low altitudes were extremely severe from a standpoint of compartment humidity.

The copilot reported that fogging of the left side of the canopy started at approximately 5,000 feet and got worse during the descent and after five minutes of the low altitude high speed dash, the fog was so bad that he couldn't see out; an attempt to wipe the canopy by hand was unsuccessful due to the excessive moisture. The pilot reported fogging of the canopy during the high speed dash but not to the extent that the copilot reported. The navigator reported partial fogging of both scan windows approximately five inches down from the top. However, the lower portion of the scans and the nose cover window remained clear. Due to misinterpretation of the test plan the camera doors were left closed for the first ten minutes of the maximum speed dash and opened the last fifteen minutes. Consequently, the navigator reported clear windows after opening the doors. It is unknown if the windows were fogged at any time during the first ten minutes of the high speed dash. Due to a malfunction of instrumentation, temperatures are not available for this test until half way through the maximum rate descent and consequently, plots were not made. However, at the start of the maximum speed dash, the nose camera window had an inside surface temperature of 43°F at T/C 66 and the viewfinder window showed a temperature of 50°F at T/C 71. The inside R.H. scan window at 1/2 throw had a temperature of 48°F at T/C 48. The upper part of the scan window was reported to have fogged, and the temperature at 3/4

throw for the R.H. and L.H. scan are 48°F and 42°F respectively. The nose cover window was reported clear even with the low inside surface temperature recorded. It appears that the compartment dew point must have varied considerably, with the lower half having a dew point much lower than the upper half. If that is the case, the compartment ventilation must be rather non-uniform with most of the airflow directed along the top of the compartment, or it also could mean that due to the lack of uniform ventilation, moisture laden air conditioning air flow used in the compartment was not circulated in the extreme forward part of the cabin. The results of the flight test of the cabin air conditioning system on the RB-47E indicate that the ventilation rate in the navigator's compartment is not uniform as reported in WD-14014 (Reference 12).

(g) Window Surface Temperature Variation with Descent

The variation of inside surface temperature at points of instrumentation of the nose camera, viewfinder, nose cover, right hand and left hand scan windows during the descent of Tests 9-1 and 9-2 is shown in Figures 15, 16, 19, 20 and 21 respectively. The probable cause of variation of temperature between thermocouples on the windows will be discussed later in this report. The increase in window surface temperature is approximately equal for both the 9-1 and 9-2 descent. The following tabulation from Reference 2 shows the calaulated temperature rise in inside surface temperature for a descent from 45,000 ft. on a design defrosting day per MIL-T-5842A (Reference 1).

Window	Design inside surface Temp. at 45,000 Ft. Altitude	Calculated Temp. Rise During Descent	Calculated Inside Surface Temp. Sea Level
	°F	°F	°F
Nose Camera	80	12	92
Viewfinder	80	15	95
Nose Cover	20	55	75
R.H.Scan	20	60	80
L.H. Scan	20	58	78

The above temperature rise was based on a constant defrosting air temperature of 160°F and a descent rate of 10,000 Ft./Min.

The following tabulation shows the inside window surface temperature

just prior to the descent and the corresponding window surface temperature at pull out for Test 9-1.

Window	Inside Window Surface Temp. at 36,000 Ft. Max.	Min.	Temperature Rise During Descent Max.	Min.	Inside Window Surface Temp. at 1500 Ft. Max.	Min.
	°F	°F	°F	°F	°F	°F
Nose Camera	44.0	41.0	11.0	5.0	55.0	46.0
Viewfinder	49.0	46.0	6.0	8.0	55.0	54.0
Nose Cover	35.0	28.0	22.0	19.0	57.0	47.0
R.H. Scan	28.0	22.0	18.0	17.0	46.0	39.0
L.H. Scan	31.0	24.0	21.0	22.0	52.0	46.0

The following tabulation is for Test 9-2.

Window	Inside Window Temp. at 37,000 Ft. Max.	Min.	Temperature Rise During Descent Max.	Min.	Inside Window Surface Temp. at 2000 Ft. Max.	Min.
Nose Camera	42.0	37.0	13.0	8.0	55.0	45.0
Viewfinder	48.0	45.0	6.0	7.0	54.0	52.0
Nose Cover	37.0	34.0	20.0	18.0	57.0	52.0
R.H. Scan	31.0	26.0	19.0	19.0	50.0	45.0
L.H. Scan	25.0	24.0	22.0	23.0	47.0	47.0

As previously stated, variables such as airspeed, power setting, rate of descent, etc. would be considered as not having any noticeable affect on window surface temperature during descent. The slight difference in window surface increase between the two tests is believed not significant enough to conclude that a design descent would result in a greater window surface temperature increase. Of greater significance is the fact that the maximum increase obtained during both flight tests for the nose camera window is approximately the same increase predicted by D-12207 Reference (2); even though the defrost air temperature at the nozzle averaged about 80°F as compared to the design defrost air temperature at the nozzle of 160°F. The viewfinder window surface temperature increase was only about half the predicted design increase, while the nose cover and scan window increase was only about

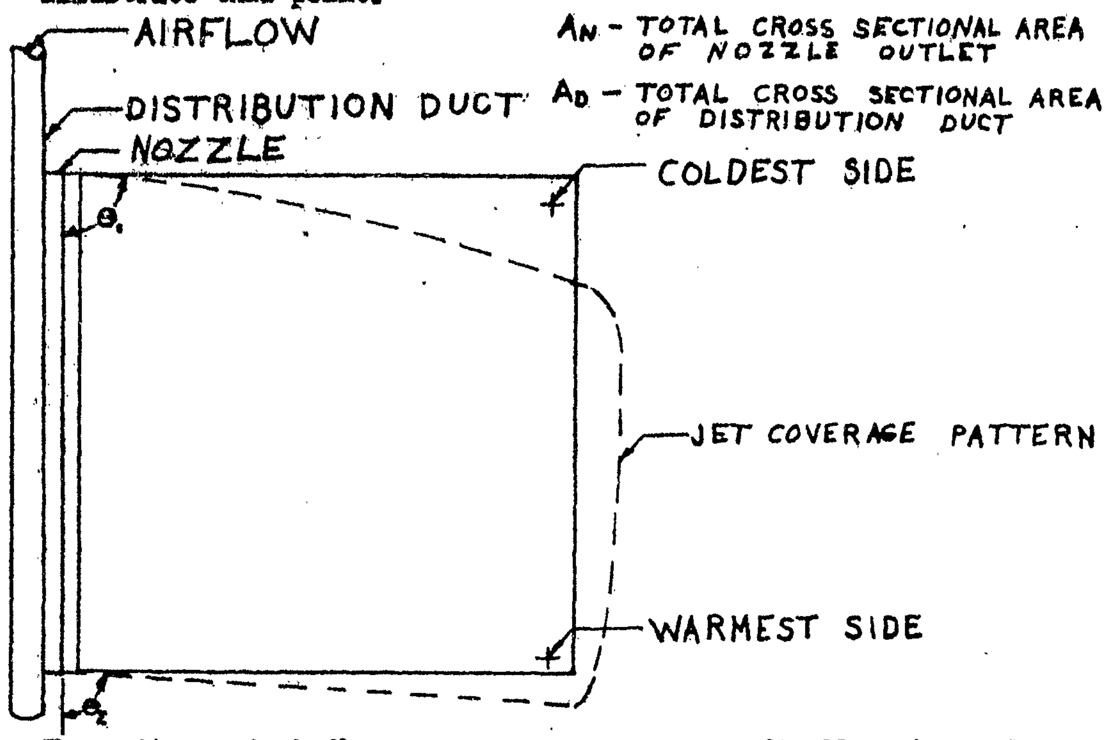
40% and 30% of the design prediction. An analytical explanation for the above is believed beyond the scope of this report and the results would only be as valid as the assumptions that would have to be made. It appears that perhaps the original design analysis could be reviewed from a standpoint of the validity of the assumptions made in predicting the transient window surface temperature change. It can be noted from the curves in Figure 22 and 23 that the window surface temperature increase during the final descent for landing of Test 9-1 and 9-2 was considerably more than that obtained during the initial descent as shown in the above tabulations. A review of the indicated OAT and descent time during the final descent has shown that there is very little difference between the initial and final descents for Test 9-1 in this respect. Therefore, it appears that the reason for the greater temperature rise is due to the defrost air temperature. The mixed air temperature at the temperature sensor decreased to a low of approximately 60°F (Figure 16) during the final descent as compared with a low of approximately 75°F (Figure 22) during the initial descent. However, it must also be noted that the difference between the mixed air temperature and the window surface temperature just prior to the descent is considerably greater for the final descent than it is for the initial descent. In the case of the viewfinder window this difference is approximately 80°F before the final descent as compared to approximately 55°F before the initial descent. This difference is not great but there may be enough residual heat in the system to cause a greater increase in window surface temperature during the final descent. In addition, the "window well" air temperature before the initial descent of 9-1 was approximately 54°F and approximately 0°F before the final descent. The difference in "well" temperature is explained by the fact that the cover doors were closed and the "well" temperature was stabilized before the initial descent, while the cover doors were open until just prior to the final descent. Due to the lack of airflow data a correlation between test and design heat transfer film coefficients cannot be made.

In conclusion, it must be pointed out that the final descent cannot be considered a design descent since the cover doors were open until just prior to the descent. The flight profile for a low level photographic mission consists of a period of stabilized flight at maximum range cruise altitude followed by a maximum rate descent and the subsequent low level photo mission. The cover doors are closed until just after pull out at low altitude.

(h) Pattern of Coverage of Defrost Air.

The reason for a difference in temperatures on individual windows is due mainly to the type of defrost nozzle used. An end-fed type nozzle is used on every window in the navigator's compartment with the exception of the outside surface of the viewfinder window. As can be noted in Figures 15 and 16, the temperatures of the viewfinder window do not have as great a difference as the nose camera window insofar

as the temperature variation is concerned. The following sketch will illustrate this point:



The pattern of airflow coverage, or more specifically, the angle θ_1 and θ_2, is a function of the ratio A_n/A_d. A numerical increase of this ratio will decrease the angles θ_1 and θ_2 and narrow the jet coverage pattern while a decrease in the ratio will widen the jet coverage pattern and consequently provide more uniform surface temperatures. The ultimate in coverage would be obtained when the angles θ_1 and θ_2 are 90°. The above is based on informal laboratory tests of a continuous slotted outlet nozzle but the results are believed applicable to an orifice type outlet nozzle, which is the type used in the defrost system. To obtain optimum airflow coverage, the total area of the orifices should only be about 25% of the cross sectional area of the supply duct. Of course, a small size orifice will increase the system pressure drop and the improvement in window coverage may have to be weighed against the affect of increased pressure drop on the upstream components, especially the blower.

(i) System Performance During a Descent on a Design Day

It has been concluded that the conditions under which the initial descents of the flight test were made could be considered typical of the conditions that would exist on a design defrosting day insofar as indicated OAT, engine RPM, etc., are concerned. Therefore, the inside window surface temperature rise during the 9-1 descent will be projected in Figures 39 and 40, to predict at what altitude during a descent on a design day that condensation will form on each window.

The inside surface temperature at 36,000 feet is an average between the two thermocouples on each window, and the temperature rise during the descent is the average temperature rise as measured by the same two thermocouples. It will be noted that the ambient dew point curve is also considered to be the cabin dew point during descent. This assumption is believed to represent the most severe condition and the following is quoted from page 6 of D-13559 (Reference 15) as substantiation:

> "The results of this study indicate that the moisture separator will have little or no effect during a rapid descent. However, the specific humidity of the cabin air will lag behind the ambient moisture content during descent because of the low rate of change of cabin air during this condition. Upon pullout with an increase of engine power, the moisture separator will become effective in time to prevent the cabin humidity level from rising to the atmospheric humidity level at that altitude."

Hence, the cabin dew point would be something less than ambient dew point. The following tabulation has been taken from Figures 39 and 40:

	ALTITUDE WHERE FROST OR FOG BEGINS TO FORM	
WINDOW	6050 ft/min Descent from 36,000 ft. Altitude - ft	6050 ft/min Descent from 39,000 ft. Altitude - ft
Nose Camera	6500	7250
Viewfinder	5250	7500
Nose Cover	6750	7000
R. H. Scan	8250	8750
L. H. Scan	7000	7500

From the foregoing it can be seen that all the windows should be clear of condensation above 8500 feet and 9000 feet for a descent from 36,000 feet and 39,000 feet respectively.

Further review of the window surface temperatures predicted at altitudes below 10000 feet during maximum rate descent from cruise altitudes, Reference Figures 39 and 40, indicates that the maximum surface temperature change with altitude from 10,000 feet to sea level is 6° F and for the two critical windows from the photo-reconnaissance standpoint this change is only 3° F maximum. Hence, it is feasible to conclude that the altitude of pullout below 10,000 feet has negligible effect on the resultant window surface temperature. In view of this a cursory and somewhat practical evaluation of the navigator's compartment defrost system performance limitations can be established in terms of the atmospheric air temperature and relative humidity conditions at the pullout altitude. Figure 40A presents such an evaluation based on the nose camera and viewfinder window surface temperatures shown in Figures 39 and 40. R

Figure 40A is applicable to any atmospheric day conditions as long as the ambient sensible temperature (dry bulb) is below 100° F. The use

of Figure 40A is illustrated by noting that for temperature conditions corresponding to approximately 500 feet altitude on a 100% Saturated Polar Standard Day (point noted on Figure 40A), no fogging of the critical windows is expected. Hence, atmospheric temperature and relative humidity conditions below the curve are expected to result in fog-free nose camera and viewfinder windows for pullout altitudes from sea level to 10,000 feet. R

(j) Inside Window Surface Temperature Increase Following Descent

The defrost system is deficient at the start of a low altitude high speed dash preceded by a maximum rate descent from high altitude. However, the inside window surface temperature will naturally rise during the high speed dash and consequently after a given period of time the window temperature may be high enough to prevent formation of any condensation.

Due to the landing gear retraction mechanism malfunction, the initial part of the low altitude high speed dash for test 9-1 cannot be used to determine the window surface temperature increase. During test 9-4 the cover doors were inadvertently left closed for the first ten minutes and opened for the last 15 minutes of the low altitude high speed dash. However, due to incomplete data just prior to and at the beginning of the high speed dash, test 9-4 data cannot be used to determine the increase in window surface temperature following a descent.

As previously stated the inside window surface temperature will increase during a low altitude high speed dash preceded by a maximum rate descent from high altitude. However, as noted above, the lack of data precludes the determination of how long after initiation of the low altitude high speed dash that the defrost system remains deficient. It is probable that the nose camera and view finder windows would be up to the design temperature of 85° F in 10 to 15 minutes after start of the dash. R

DISCUSSION

A. Acceptable Performance of System Components

1. Blower Performance

The blower is considered to have operated satisfactorily at high altitude. Erratic blower operation was noted during the low altitude conditions but as noted in "Evaluation of Results" this was believed to result from the fluctuating bleed airflow. It was also noted that the motor did not appear to overspeed and since the airflow requirements at low level are not critical it is believed that blower operation is satisfactory from a standpoint of system performance.

2. Overheat Control and System Safety Devices

The laboratory test of the cabin defrost system, T-28288 (Reference 3) reports that system overheat controls and safety devices operated satisfactorily and therefore, these components were not checked during the flight test program.

3. Temperature Control System

The temperature control system functioned satisfactorily whenever the defrost system operation was free from malfunctions of the other components of the defrosting system. Satisfactory control system functioning was evidenced in that no significant instability of the controlled temperature existed, nor did the temperature exceed the upper control limit, during proper defrost system design functioning. The only major indications of control temperature fluctuations were evident during defrosting system malfunction such as when the limit switches failed to close the bleed air supply modulation valve during camera door "open" conditions, Reference Figure 38. Minor fluctuations in control temperature did occur during certain power changes. The control temperature stayed within the 160 ± 5°F control band whenever the bleed air temperature and pressure was sufficiently high so that the bleed air flow from the wide open modulating valve would result in a mixed air temperature within the 160 ± 5° band.

4. Modulation Valve Stability

The modulation valve operation was stable during all normal defrosting system operating conditions. A slight "hunting" of the valve occurred for approximately 3 minutes after the temperature control limits were exceeded by the result of large power change as indicated in Figure 11. In all cases where the bleed air conditions were not sufficient to produce a mixed air temperature within the temperature control band the valve remained in the full open position moving from this position only to satisfy the demands of the temperature control system or the intervention of the limit switch circuit actuated by the opening of the camera doors.

B. Deficiencies of System Components

The overall system deficiency may be a result of the following:

1. During the majority of the conditions requiring the camera doors to be open the modulation valve did not close according to the defrosting system design. The system was designed to shut off the flow of hot air over the outside of the windows during doors open operations since the effect of the hot air stream on photographic clearness was not known but thought to be detrimental. In addition, this system malfunction was inconsistent in its effect on the modulation valve stability, i.e., in some cases severe "hunting" occurred and in other cases the valve remained stable. The "hunting" of the valve is contributed to improper operation of the limit switches when the camera doors are opened and/or closed. As shown in Figures 28 and 38, instability did not occur when the doors were first opened for the low altitude photo mission of Test 9-1, but it did occur during the period when the doors were open and continued during, and to some extent after the closing of the doors. Figures 32 and 38 indicate that the severe "hunting" occurred during the entire doors open condition of the Test 9-4 low altitude photo mission and that the hunting ceased after the doors were closed. Figure 30 indicates that during the doors open portion of the high altitude photo mission of Test 9-1 the modulation valve did not close nor did it "hunt". Also, Figure 31 shows that the modulation valve properly closed during the 9-2 high altitude photo mission and consequently no hunting occurred.

   It is further observed from Figures 28, 31, 32 and 38 that instability only occurred when the malfunction occurred at low altitude.

2. The compartment temperature in the nose camera and viewfinder window area was recorded at approximately 40°F, just prior to the maximum rate descent, or a departure of 30°F from the D-12207 design analysis value of 70°F.

3. The temperature drop in the duct system was excessive. A mixed air temperature drop of approximately 20°F was recorded from the temperature control sensor to the nose camera and viewfinder window defrost nozzle outlets and the mixed air temperature at the sensor was only about 105°F. As previously noted, this temperature drop is believed to result from leakage of cabin air into the duct system through the 9-30129 transition assembly and the 6-43907 air check valves. The bleed air temperature drop from the bleed port to the defrost duct takeoff was about 60°F or approximately twice the original assumed drop of 35°F used in the design analysis. However, the temperature drop from the defrost duct takeoff to the mixing duct in the cabin averaged about 10°F and this resulted in a bleed

air temperature into the mixing duct of less than 160° F, which was the design mixed air temperature. Therefore, it is seen that the overall temperature drop from the bleed port to the defrosting nozzles averages 170° F.

4. The defrosting air jet pattern is such that a considerable variation in window surface temperature at maximum throw exists for all windows except the viewfinder window. The viewfinder defrost nozzle design (center-fed nozzle) provides more uniform coverage than the end fed spray tubes used for the other windows.

5. The control system that closes the modulating valve when both cover doors are opened did not operate satisfactorily. It has been concluded that the system deficiency may be attributed to limit switch malfunction. This apparent malfunction did not appear to have any appreciable affect on system performance. As previously mentioned, the design of the defrosting system included the provision for closing the modulation valve during doors open operation in order to eliminate possible detrimental effects of the hot air passing over the window outer surface during photography. Since the absolute necessity of this provision has not been confirmed consideration should be given to the possibility of removing this control in the interest of defrosting system simplification.

6. As previously stated airflow distribution to the various windows was not determined. However, the total mixed airflow through the venturi compares favorably with the D-12207 design analysis.

C. Improvements

The following recommendations are possible ways of improving the navigator's compartment defrost system performance:

1. Close the navigator's manual shut off valve and cut off power to blower above 35,000 feet by actuating the circuit breaker on the navigator's panel. The nose cover and scan windows will not be provided with any defrosting air above 35,000 feet when the navigator's valve is off. Cabin pressure should not be adversely affected since the bleed airflow is approximately equal to the venturi flow above 35,000 feet. Turn blower on during the photographic missions when the camera doors are open. R

2. Increase the outside defrost air temperature control from 160 ± 5° F to as high a value as possible but not in excess of 175 ± 5° F. Control power to the blower by means of a temperature control that will shut off power to the blower when the mixed air temperature drops below 160° F, or when the compartment temperature at the blower inlet drops below 70° F. Remove the reverse flow thermal switch on the blower and install a check valve downstream of the blower outlet to prevent reverse flow through the blower. Removal of the reverse flow thermal switch is recommended since installation of the check valve will prevent reverse flow through the blower. Replace the present modulating valve with one that will permit passage of a

bleed airflow rate of approximately 3.6 lbs/min (the camera compartment defrosting system modulation valve has a maximum opening of 47.5°, as compared to 21° for the present valve, and could perhaps be used). A bleed airflow rate of 3.6 lbs/min should be enough to provide defrost airflow for the nose camera, viewfinder, nose cover and both scan windows, as well as the necessary airflow for the "inside defrosting" of the nose camera and viewfinder window when the blower is inoperative and the cover doors are open during a high altitude photo reconnaissance mission. In view of the added control systems necessary for this fix, and to reduce the complexity, it may be desirable to remove the control system that closes the modulating valve when the cover doors are open. System performance did not appear to be adversely affected when the cover doors were open and the modulation valve was open during the flight tests. During a low level photo reconnaissance mission, the blower will be on and the temperature sensor will control the bleed airflow to maintain a mixed air temperature of 175 ± 5°F. In event that this is accomplished, some consideration must be given to possible adverse effects of hot air passing over either the inside or outside surface of the window during photography.

3. Additional defrost protection can be provided to the nose camera and viewfinder windows by redesigning the 6-43907 defrost air check valves and the 9-30129 transition assembly. This redesign would eliminate leakage of cold cabin air into the defrost air ducts and provide a potential increase in defrost air temperature at the nozzle outlet of approximately 20°F, based on the flight test results.

4. If maximum protection is desired the following could be accomplished:

   (a) Redesign the defrost nozzle outlets to obtain more uniform airflow coverage and also decrease the air jet temperature decay.

   (b) Insulate the window wells to reduce heat transfer and consequently reduce the temperature decay of the air jet.

   (c) Investigate the possibility of increasing the insulation on the bleed air supply line in order to reduce the temperature drop from the modulating valve to the mixing duct.

The increase in defrost protection to be expected by incorporation of the above improvements is given in the "Conclusions and Recommendations" section of this document. The determination of the altitudes above which condensation should not form was on an approximate basis and should only be used as a guide for establishing which improvement should be subjected to a formal design analysis. The following is an example of the methods used to determine the increase in protection if Improvement 1 is accomplished and a descent is made from 36,000 Ft:

Assume:

1. Steady state altitude approximately 36,000 Ft.

2. Defrost blower turned off.

3. Navigator's shutoff valve closed.

4. Straight bleed air used for defrosting at a temperature of approximately 140°F (Figure 18).

5. Defrost air temperature at sensor approximately 130°F.

6. Defrost air temperature at nozzle outlet for nose camera and viewfinder window approximately 105°F.

From Figure 15, the average defrost air temperature at the sensor is approximately 104°F and just upstream of the defrost nozzle outlet the average air temperature is approximately 83°F. The average nose camera window surface temperature resulting from the above nozzle air temperature is approximately 40°F, at an altitude of approximately 36,000 Ft.

It will be assumed that the window surface temperature will increase by a direct proportion to the nozzle air temperature increase:

$$\frac{105}{t_1} = \frac{83}{40}$$

t_1 = 50.6°F (nose camera inside window surface temperature at 36,000 Ft.)

Δt = 9°F (Average nose camera window inside surface temperature rise during descents for tests 9-1 and 9-2; paragraph (g) of "Evaluation of Results".)

It is assumed that the average window surface temperature rise obtained in the flight test descents can be applied to any descent from high altitude to altitudes below 5000 Ft.

t_2 = 50.6 + 9 = 59.6°F (Nose camera window inside surface temperature at the end of a descent from 36,000 Ft.)

Using the same method and referring to Figure 16 the viewfinder window surface temperature at the end of a descent from 36,000 Ft. should be:

$$\frac{105}{t_1} = \frac{84}{48}$$

t_1 = 60°F (viewfinder window inside surface temperature at 36,000 Ft.)

Δt = 7°F (average viewfinder window inside surface temperature rise during descents for tests 9-1 and 9-2; paragraph (g) of "Evaluation of Results".)

t_2 = 60+7=67°F (viewfinder window inside surface temperature at the end of a descent from 36,000 Ft.)

From Figure 39 it can be seen that the ambient dew point at an altitude of 4500 Ft. is 58°F. Since the nose camera window inside surface temperature is only 59.6°F, it is considered that the descent should be limited to 4500 Ft., if the nose camera and viewfinder windows are to be free of condensation. Since it was assumed the navigator's manual shut off valve was closed above 35,000 Ft. the nose cover and scan windows will not receive any defrost airflow prior to the descent and therefore, the defrost protection to these windows will be marginal at 4500 Ft.

CONCLUSIONS AND RECOMMENDATIONS

The defrost system is marginal in providing a frost-free camera and viewfinder window during a high altitude maximum range cruise photo reconnaissance mission. The nose cover and scan windows will be maintained frost free during this condition. The system is deficient at the start of a low altitude mission which is preceded by a maximum rate descent from high altitude, as explained in Paragraph (j) of "Evaluation of Results".

The following recommendations are made with consideration given to the type of mission to be accomplished on a design defrosting day per MIL-T-5842A, Reference 1:

A. High Altitude Photographic Reconnaissance Missions

Incorporation of Improvement 1 as listed in "Discussion" should provide slightly increased protection against frost for any high altitude photo mission. The incorporation of Improvement 2 would provide adequate protection during the high altitude photo mission.

The altitude limitations in the following recommendations were determined by the method outlined in the "Discussion" section of this document and as noted therein should only be considered as approximations.

B. Low Level Photographic Reconnaissance Missions Preceded by Maximum Rate Descent from 36,000 Feet

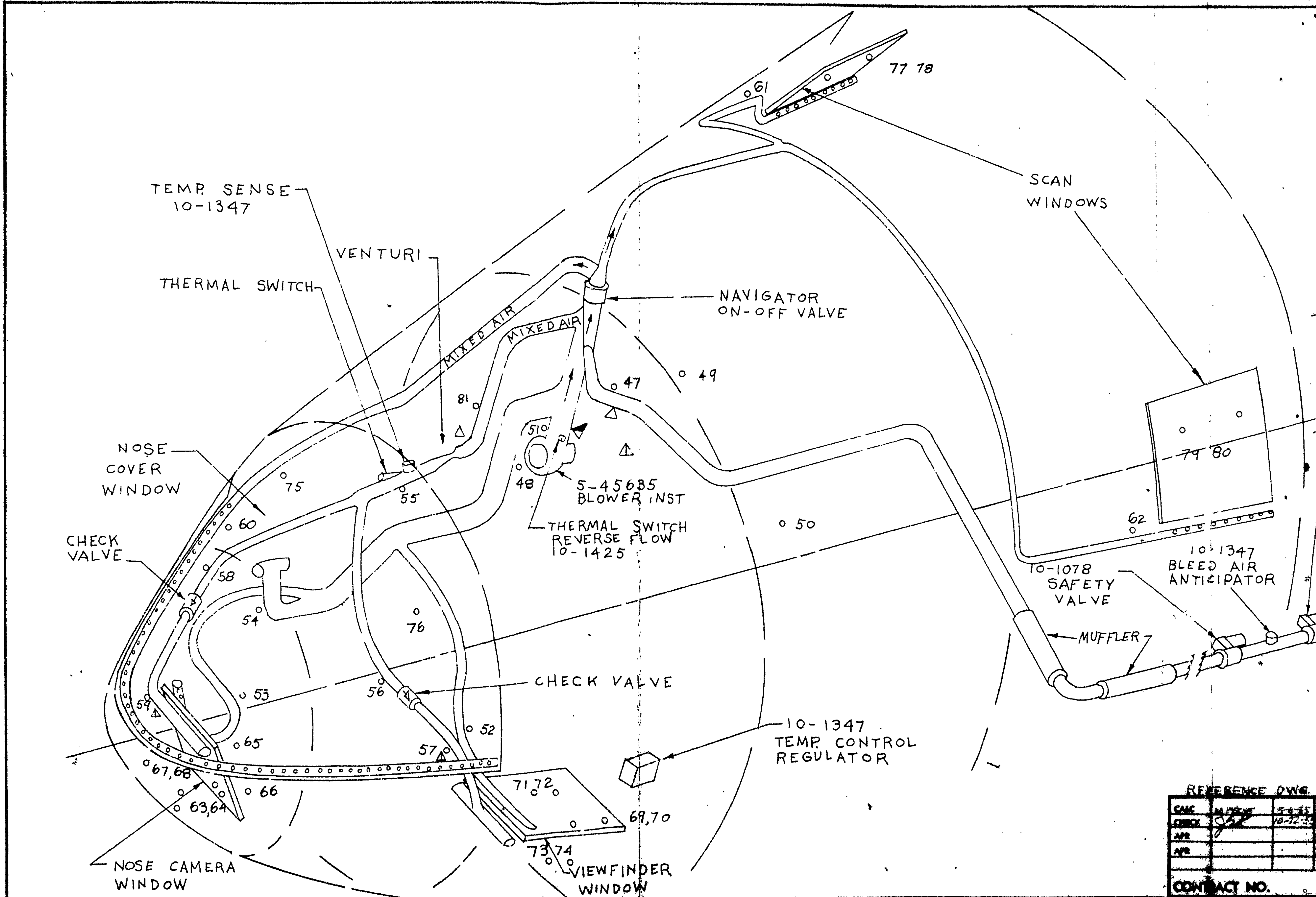
1. Low Level Missions above 4500 feet

It is believed that incorporation of Improvement 1 from the "Discussion" will provide adequate protection against condensation on the nose camera and viewfinder windows if the low level photographic mission is accomplished at 4500 feet or above. The protection afforded the nose cover and scan windows would perhaps be marginal.

2. Low Level Missions below 4500 feet

If Improvement 2 were accomplished, the nose camera and viewfinder windows will be adequately protected against condensation for a low level photographic mission at or above 2000 feet. The nose cover and scan windows would be provided with adequate protection to approximately 3000 feet but may have marginal protection at 2000 feet

If the ultimate in protection is required for all windows to meet the maximum requirements of the defrost specification MIL-T-5842A, then incorporation of Improvements 2, 3, and possibly 4 will be necessary.



TEMP. SENSE
10-1347
VENTURI
THERMAL SWITCH
NAVIGATOR
ON-OFF VALVE
SCAN
WINDOWS
77 78
61
MIXED AIR
MIXED AIR
81
47
49
51
48
5-45635
BLOWER INST
THERMAL SWITCH
REVERSE FLOW
10-1425
50
NOSE
COVER
WINDOW
75
55
60
58
CHECK
VALVE
54
76
53
56
CHECK VALVE
59
65
57
52
67,68
66
63,64
NOSE CAMERA
WINDOW
71 72
69,70
73 74
VIEWFINDER
WINDOW
10-1347
TEMP. CONTROL
REGULATOR
79 80
62
10-1347
BLEED AIR
ANTICIPATOR
10-1078
SAFETY
VALVE
MUFFLER
REFERENCE DWG.
CALC
CHECK
APR
APR
CONTRACT NO.

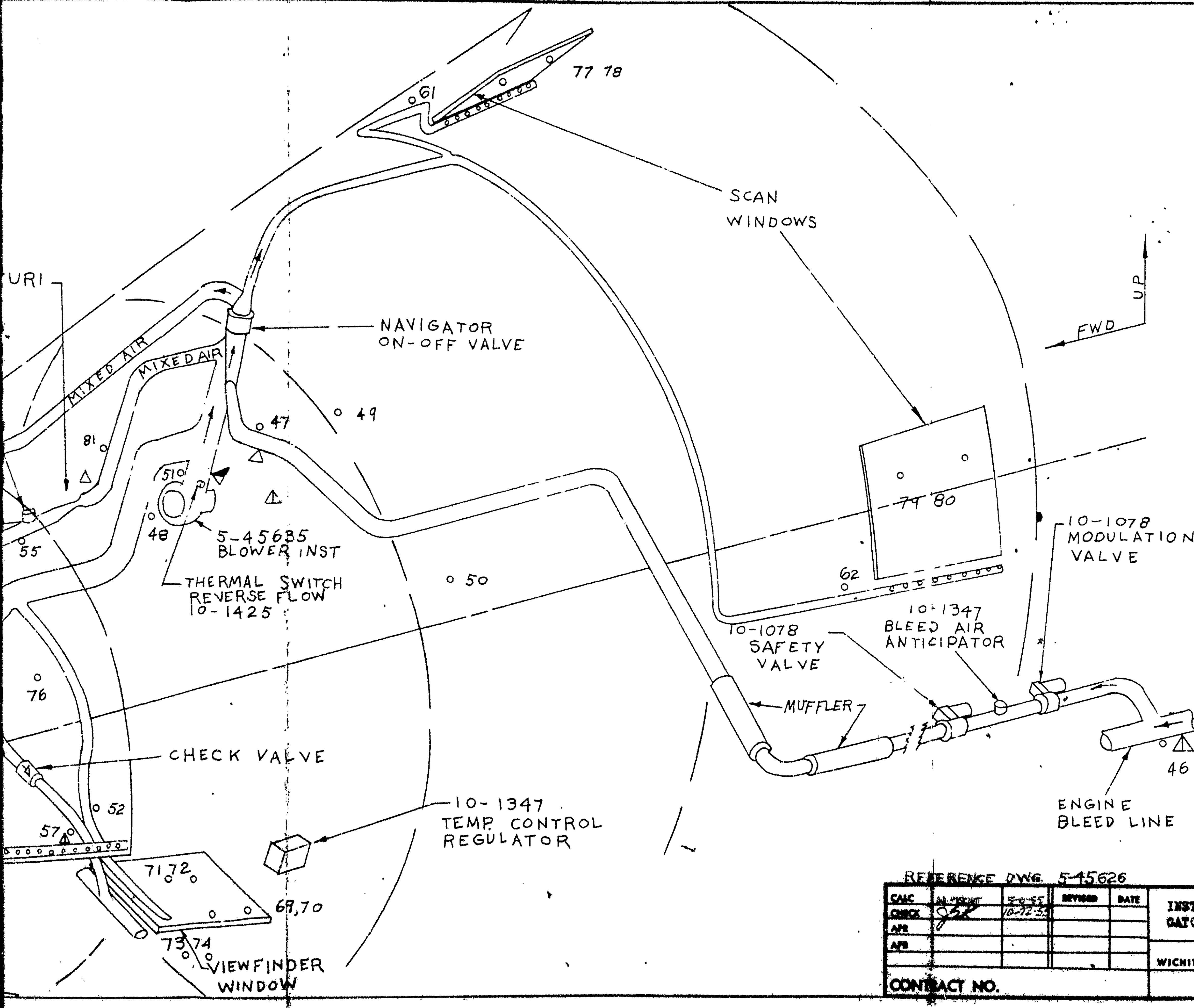


FIGURE NUMBER	PICKUP NUMBER	INSTRUMENTATION DETAIL: THERMO-COUPLE	STATIC PRESSURE PICKUP	TOTAL PRESSURE PICKUP
41	46	✓	✓	
42	47		✓	✓
43	48			
	49			
	50			
44	51			✓
	52			
	53			
	54			
	55			
	56			
	57		✓	
	58			
45	59		✓	
	60			
	61			
	62			
46	63			
46	64			
46	65			
46	66			
47	67			
48	68			
49	69			
49	70			
49	71			
49	72			
50	73			
51	74			
52	75			
52	76			
53	77			
53	78			
53	79			
53	80			
	81		✓	✓

REFERENCE DWG. 5-45626

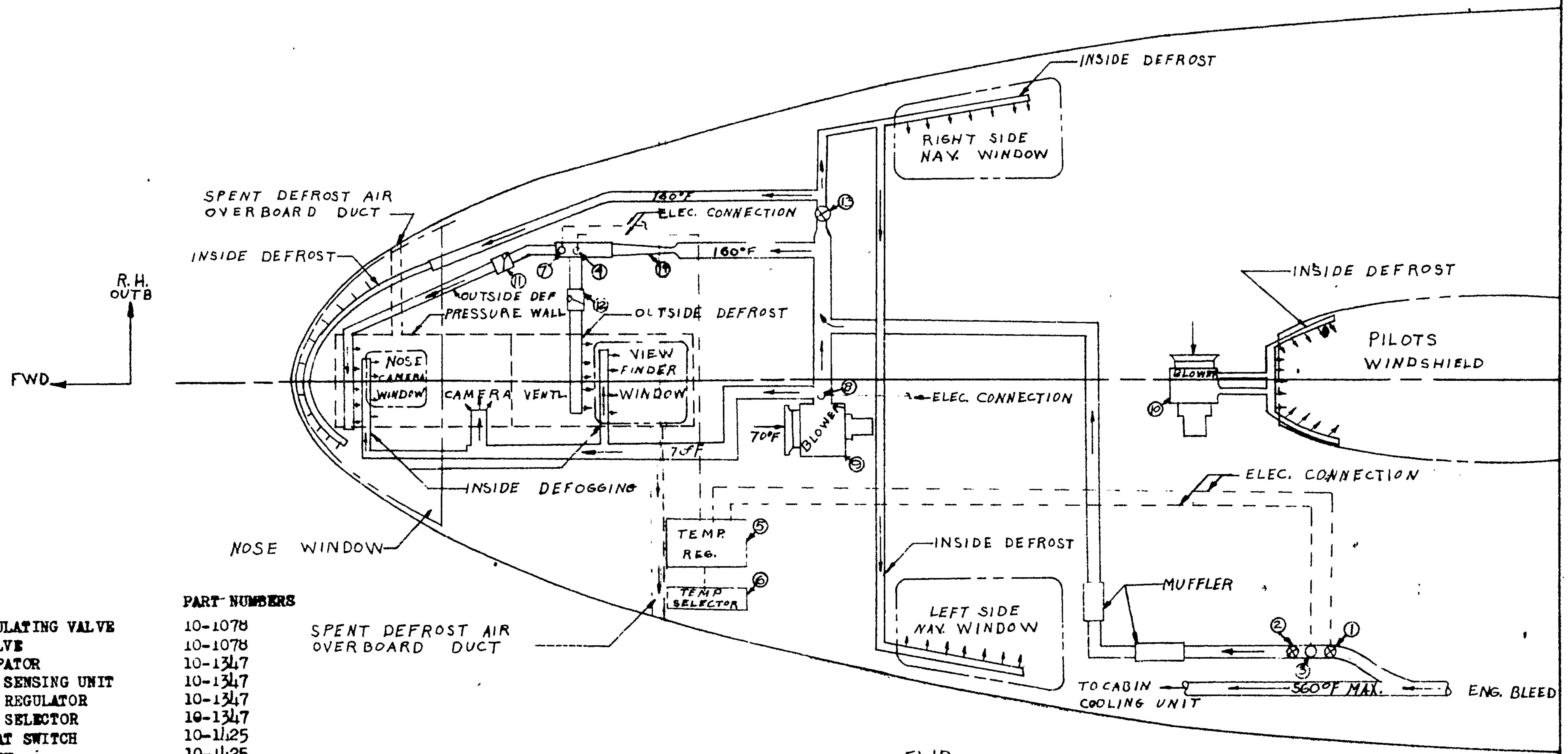
CALC		5-6-55	REVISED	DATE
CHECK		10-12-55		
APR				
APR				

CONTRACT NO.

INSTRUMENTATION LOCATION FOR NAVIGATOR'S COMPARTMENT DEFROSTING SYSTEM

BOEING AIRPLANE COMPANY
WICHITA DIVISION WICHITA 1, KANSAS

FIGURE 1
RD-478
WD-14018
PAGE 49

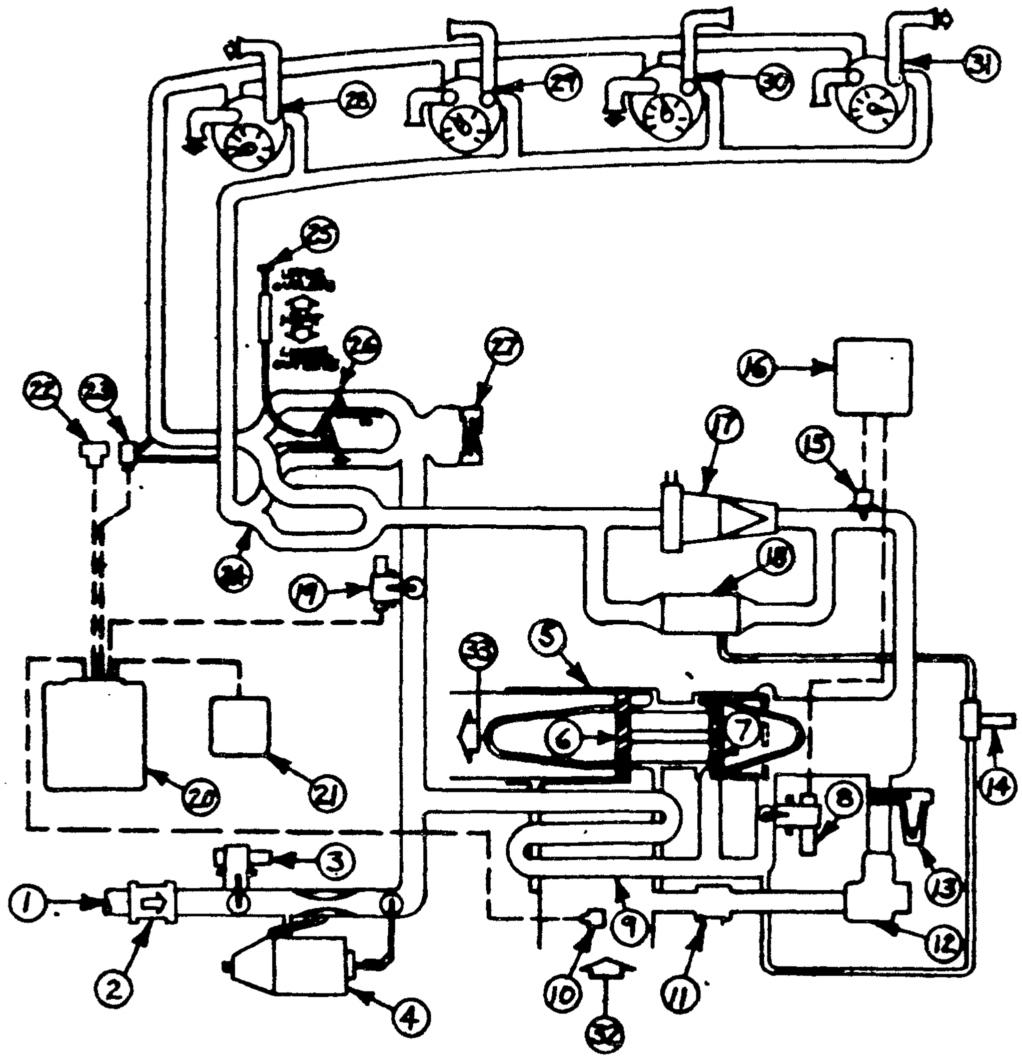


		PART NUMBERS
1.	DEFROST MODULATING VALVE	10-1078
2.	SHUT-OFF VALVE	10-1078
3.	DUCT ANTICIPATOR	10-1347
4.	TEMPERATURE SENSING UNIT	10-1347
5.	TEMPERATURE REGULATOR	10-1347
6.	TEMPERATURE SELECTOR	10-1347
7.	DUCT OVERHEAT SWITCH	10-1425
8.	THERMO SWITCH	10-1425
9.	DEFROST BLOWER	9-19205
10.	WINDSHIELD DEFROST BLOWER	10-1029
11.	SWING CHECK VALVE	6-43907
12.	SWING CHECK VALVE	6-43907
13.	PHOTO-NAVIGATORS WINDOW DEFROST BUTTERFLY VALVE	9-29980
14.	VENTURI	6-44294

COPIED FROM 9-25805

CALC	M. PECHT	6-55	REVISED	DATE	SYSTEM DIAGRAM NOSE DEFROST	FIGURE 2
CHECK	[illegible]	10-22-55				RB-47E
APR					BOEING AIRPLANE COMPANY	MD-14018
APR					WICHITA, KANSAS	PAGE 50
CONTRACT No.						OF

FORM E 1296



1-Compressed air from engines
2-Engine bleed air check valve
3-Hot air shut-off valve
4-Flow control valve
5-Cooling unit package
6-Blower
7-Turbine
8-Turbine by-pass valve
9-Heat exchanger
10-Ambient temperature anticipator
11-Ram air check valve
12-Ground blower
13-Ram air shut-off valve
14-Solenoid valve
15-35°F Electronic temperature sensor
16-Electronic 35°F temperature regulator
17-Water separator
18-Water separator by-pass valve
19-Cooling unit by-pass valve
20-Cabin temperature regulator
21-Cabin temperature selector rheostat
22-Cabin temperature sensor
23-Duct temperature anticipator
24-Mixing chamber
25-Heat distribution valve control
26-Heat distribution valve
27-Spill valve
28-Navigator's selector valve
29-Pilot's selector valve
30-Co-pilot's selector valve
31-Weaponeer's selector valve
32-Coolant air in
33-Coolant air out

CALC	RMS		REVISED	DATE
CHECK	WAM	10/14/53		
APR				
APR				

RB-47E CABIN AIR CONDITIONING SYSTEM, AF 51-5258

FIGURE 2A

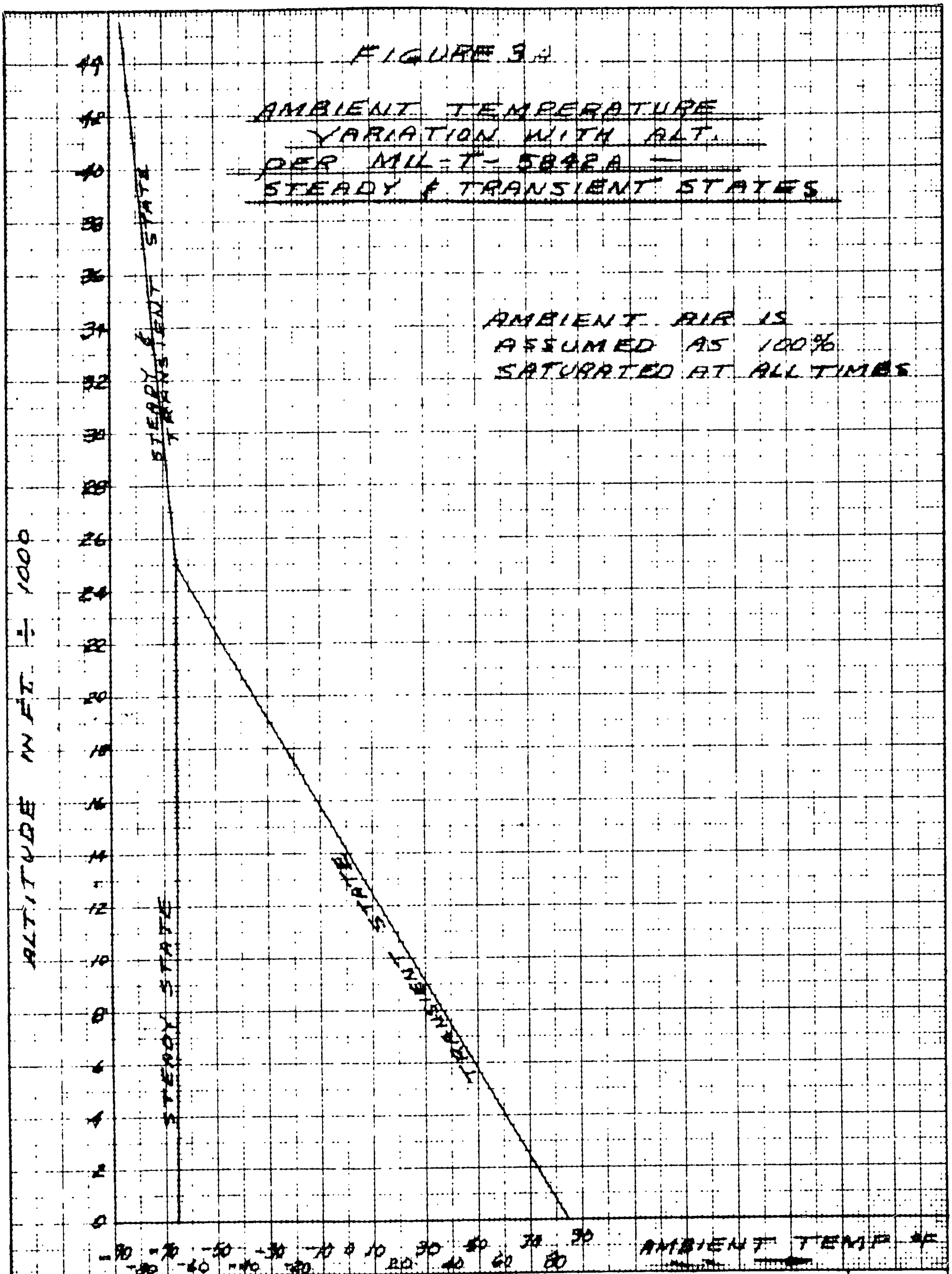
RB-47E

BOEING AIRPLANE CO.
WICHITA DIVISION — WICHITA 1, KANSAS

WD-14018

CONTRACT NO.

E-1196



CALC		10-22-55	REVISED	DATE	AMBIENT TEMPERATURE VARIATION WITH ALT. PER MIL-T-5842A - STEADY AND TRANSIENT STATES	FIGURE 3
CHECK						RB-47E
APR					BOEING AIRPLANE COMPANY WICHITA 1, KANSAS	MD-14018
APR						PAGE 52
CONTRACT NO.						OF

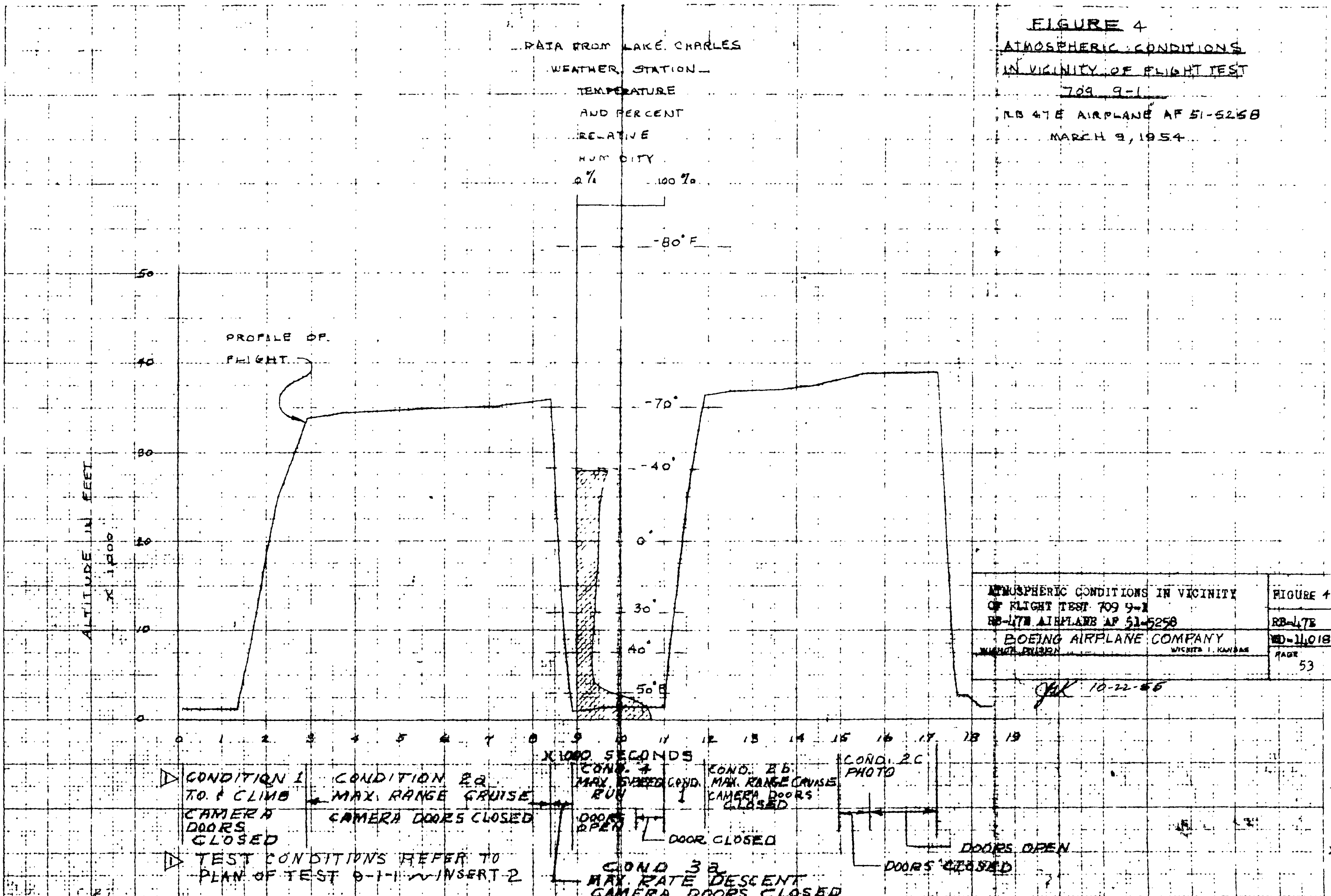
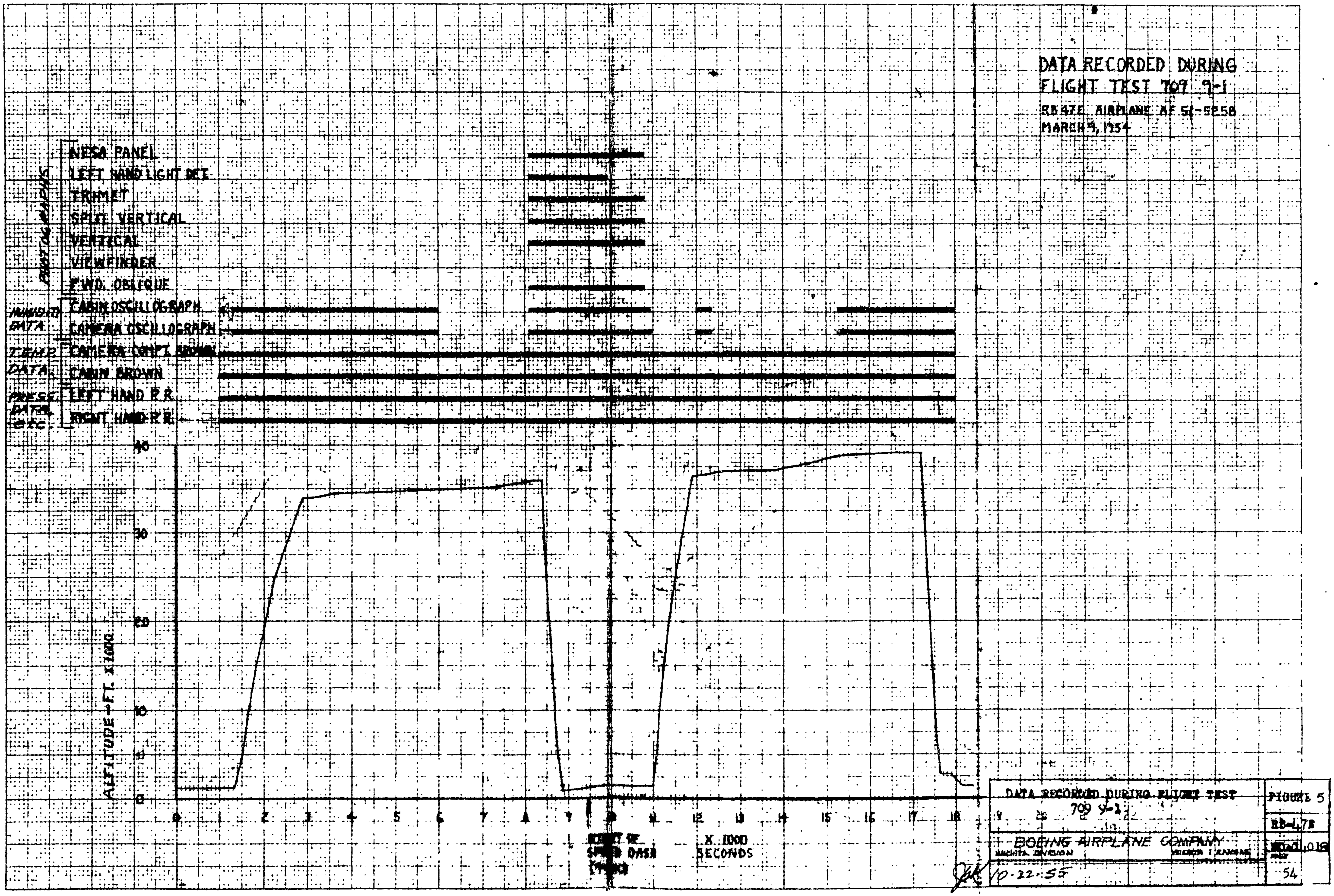


FIGURE 4
ATMOSPHERIC CONDITIONS
IN VICINITY OF FLIGHT TEST
709 9-1
RB 47E AIRPLANE AF 51-5258
MARCH 9, 1954
DATA FROM LAKE CHARLES
WEATHER STATION
TEMPERATURE
AND PERCENT
RELATIVE
HUMIDITY
0%
100%
-80°F
-70°
-40°
0°
30°
40°
50°F
PROFILE OF
FLIGHT
ALTITUDE IN FEET
X 1000
0
10
20
30
40
50
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
X1000 SECONDS
CONDITION 1
T.O. & CLIMB
CAMERA
DOORS
CLOSED
CONDITION 2a
MAX. RANGE CRUISE
CAMERA DOORS CLOSED
COND. 4
MAX. SPEED RUN
DOORS OPEN
COND. 1
DOOR CLOSED
COND. 2b
MAX. RANGE CRUISE
CAMERA DOORS
CLOSED
COND. 2C
PHOTO
DOORS OPEN
DOORS CLOSED
COND 3a
MAX. RATE DESCENT
CAMERA DOORS CLOSED
TEST CONDITIONS REFER TO
PLAN OF TEST 9-1-1 ~ INSERT 2
ATMOSPHERIC CONDITIONS IN VICINITY
OF FLIGHT TEST 709 9-1
RB-47E AIRPLANE AF 51-5258
BOEING AIRPLANE COMPANY
WICHITA DIVISION
WICHITA, KANSAS
FIGURE 4
RB-47E
D-11,018
PAGE
53
10-22-56



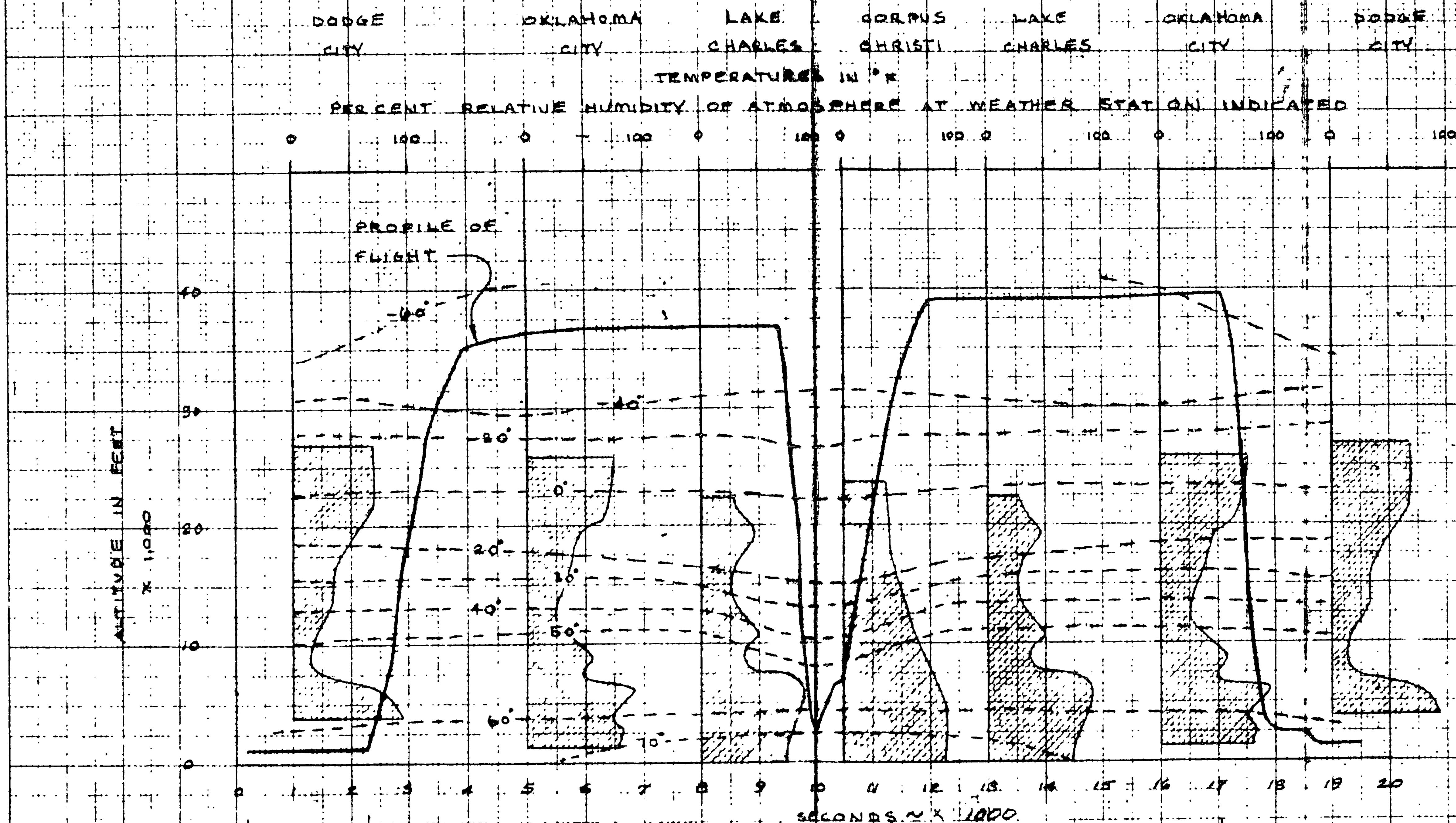
DATA RECORDED DURING
FLIGHT TEST 709 9-1
RB 47E AIRPLANE AF 51-5258
MARCH 9, 1954
NESA PANEL
LEFT HAND LIGHT DET
TRIMET
SPLIT VERTICAL
VERTICAL
VIEWFINDER
FWD. OBLIQUE
CABIN OSCILLOGRAPH
CAMERA OSCILLOGRAPH
CAMERA COMPT. BROWN
CABIN BROWN
LEFT HAND P.R.
RIGHT HAND P.R.
PHOTOG RAPHS
HUMIDITY DATA
TEMP DATA
PRESS. DATA, ETC.
ALTITUDE - FT. X 1000
0
10
20
30
40
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
X 1000 SECONDS
START OF SPEED DASH
DATA RECORDED DURING FLIGHT TEST 709 9-1
BOEING AIRPLANE COMPANY
WICHITA DIVISION
WICHITA, KANSAS
10-22-55
FIGURE 5
RB-47E
54

FIGURE 6

ATMOSPHERIC CONDITIONS IN VICINITY OF FLIGHT TEST 709 9-2

RB 47E AIRPLANE AF 51-5258

APRIL 27, 1954



CONDITION 1 T.O. & CLIMB DOORS CLOSED

COLD SOAK AT MAX. RANGE CRUISE DOORS CLOSED

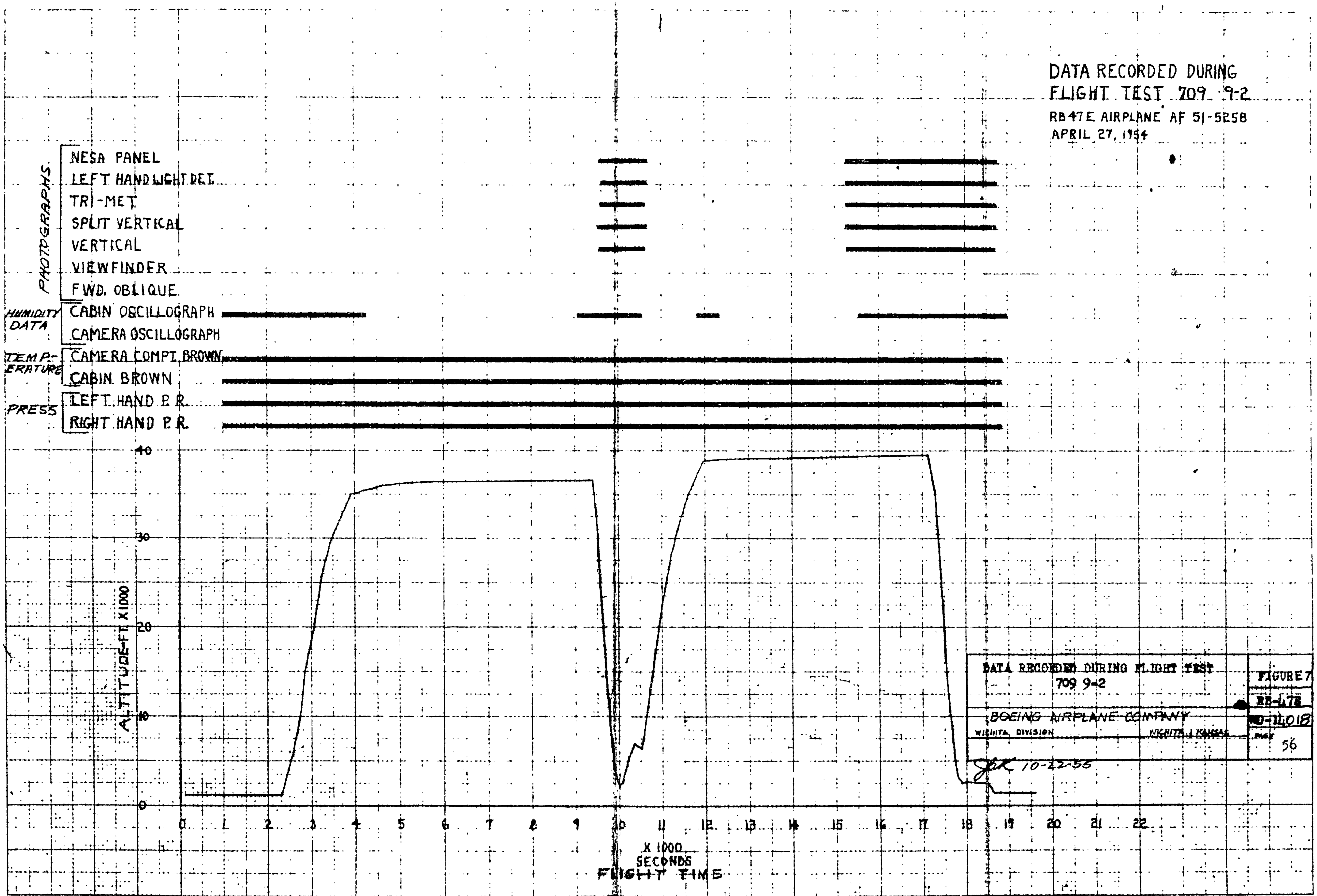
RETURN TO ALT AFTER ABORTING LOW LEVEL DASH

HIGH ALT. PHOTO MAX. RANGE CRUISE DOORS CLOSED | DOORS OPEN

MAX RATE DESCENT DOORS CLOSED

TEST CONDITIONS REFER TO PLAN OF TEST 9-14 ~ INSERT 2

ATMOSPHERIC CONDITIONS IN VICINITY OF FLIGHT TEST 709 9-2	FIGURE 6
	RB-47E
BOEING AIRPLANE COMPANY WICHITA DIVISION WICHITA, KANSAS	MD-11018
10-22-55	PAGE 55



DATA RECORDED DURING
FLIGHT TEST 709 9-2
RB47E AIRPLANE AF 51-5258
APRIL 27, 1954
PHOTOGRAPHS
NESA PANEL
LEFT HAND LIGHT DET.
TRI-MET
SPLIT VERTICAL
VERTICAL
VIEWFINDER
FWD. OBLIQUE
HUMIDITY DATA
CABIN OSCILLOGRAPH
CAMERA OSCILLOGRAPH
TEMPERATURE
CAMERA COMPT. BROWN
CABIN BROWN
PRESS
LEFT HAND P.R.
RIGHT HAND P.R.
ALTITUDE-FT X1000
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
X 1000
SECONDS
FLIGHT TIME
DATA RECORDED DURING FLIGHT TEST
709 9-2
BOEING AIRPLANE COMPANY
WICHITA DIVISION
WICHITA, KANSAS
FIGURE 7
D-14018
56
10-22-55

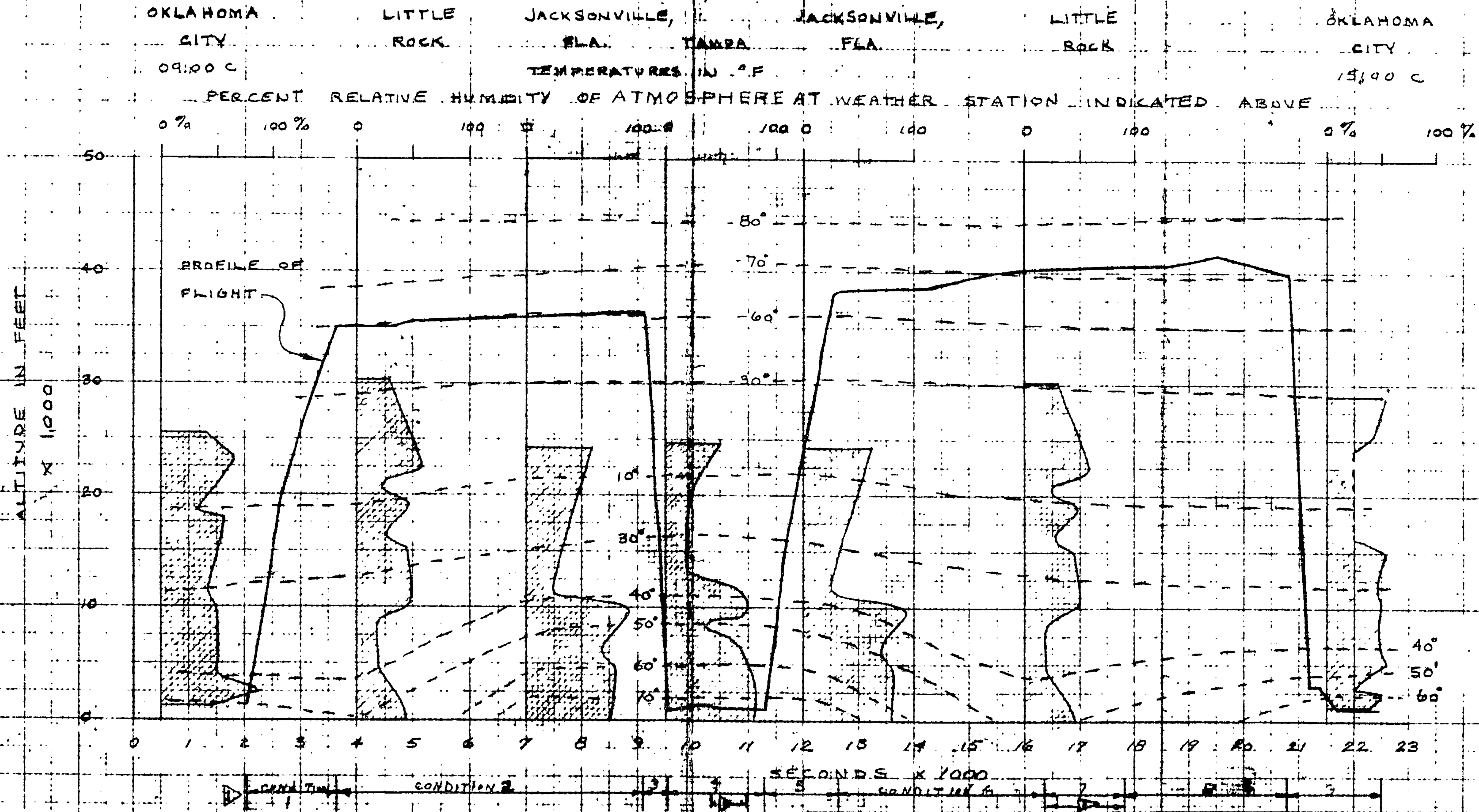
FIGURE 8

ATMOSPHERIC CONDITIONS IN VICINITY OF FLIGHT TEST 709 9-4

RB-47E AIRPLANE AF 51-5258

MAY 4, 1954

▷ TEST CONDITIONS REFER TO PLAN OF TEST 9-1-1 ~ INSERT 2



1. TAKE-OFF & CLIMB DOORS CLOSED
2. MAX RANGE CRUISE COLD SOAK
3. MAX RATE DESCENT
4. MAX SPEED DASH ▷ DOORS OPEN
5. CLIMB TO CRUISE ALTITUDE
6. MAX RANGE CRUISE COLD SOAK
7. HIGH ALT. PHOTO MISSION ▷ DOORS OPEN
8. HIGH ALT. CRUISE
9. MAX RATE DESCENT

CALC	JBK	10-22-55
CHECK		
APR		
APR		

ATMOSPHERIC CONDITIONS IN VICINITY OF FLIGHT TEST 709 9-4

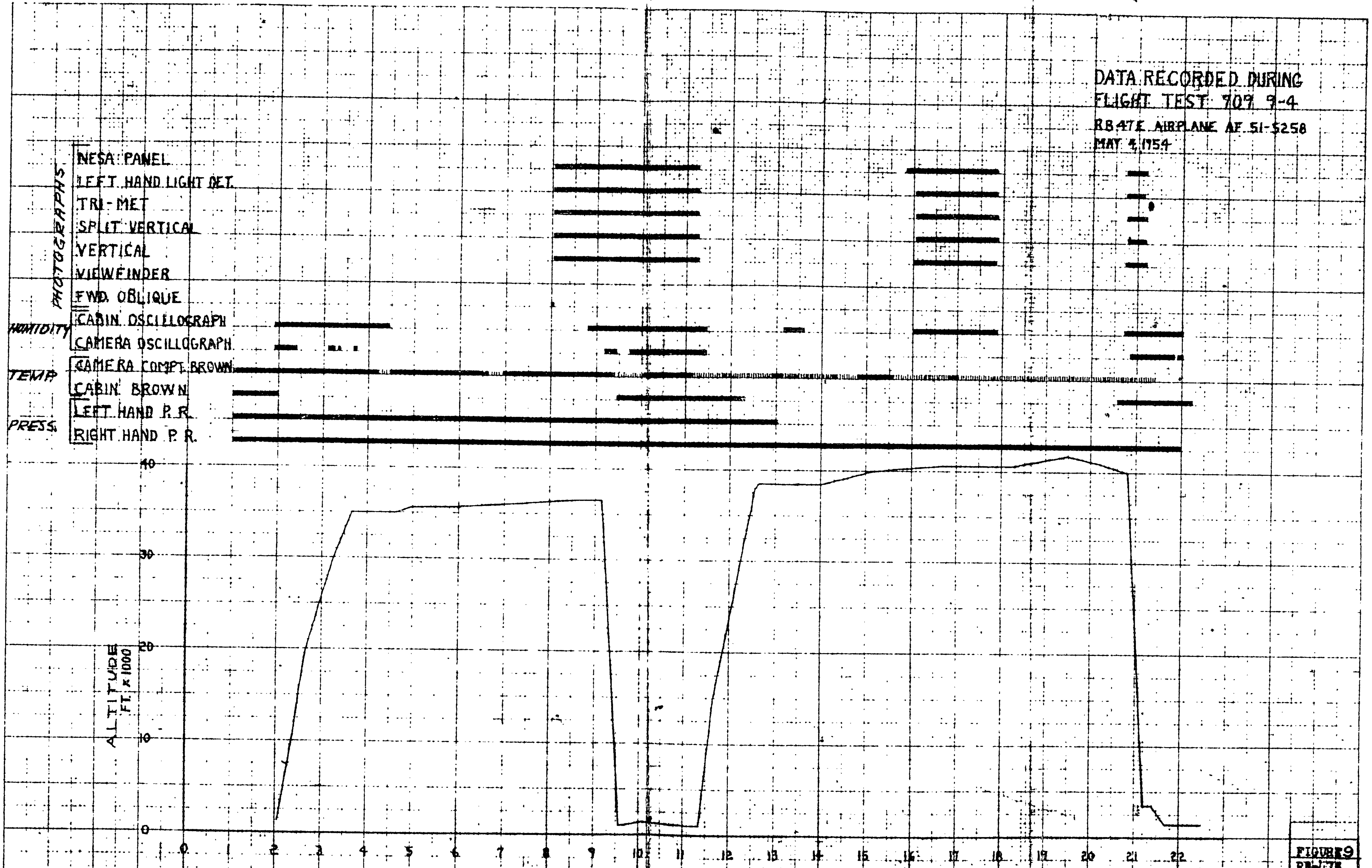
BOEING AIRPLANE COMPANY WICHITA DIVISION WICHITA, KANSAS

CONTRACT NO.

FIGURE 8

RB-47E

NO. D-11,018

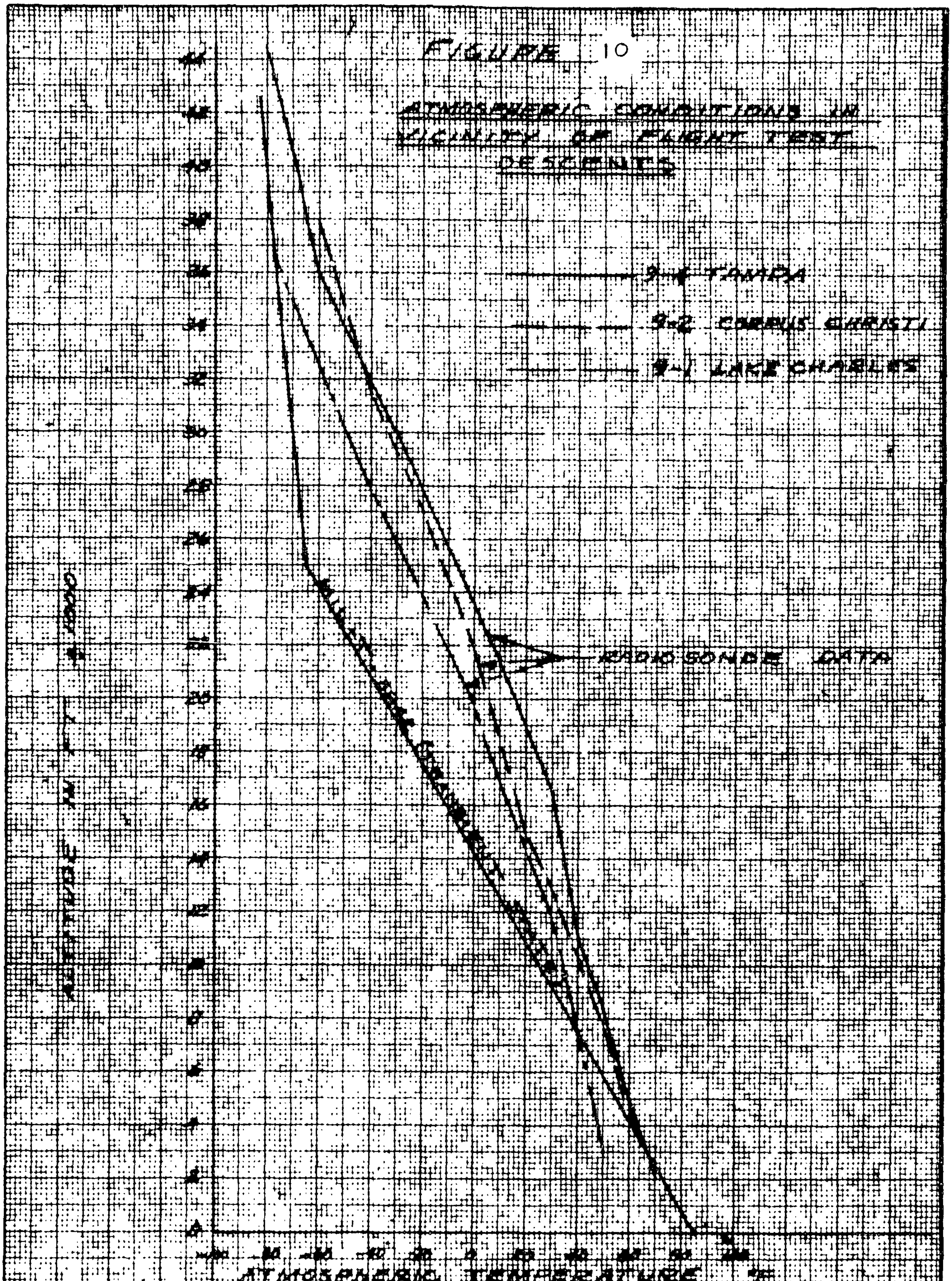


CALC.		10-22-55	REVISED
CHECK			
APPR.			
APPR.			

DATA RECORDED DURING FLIGHT TEST 709 9-4

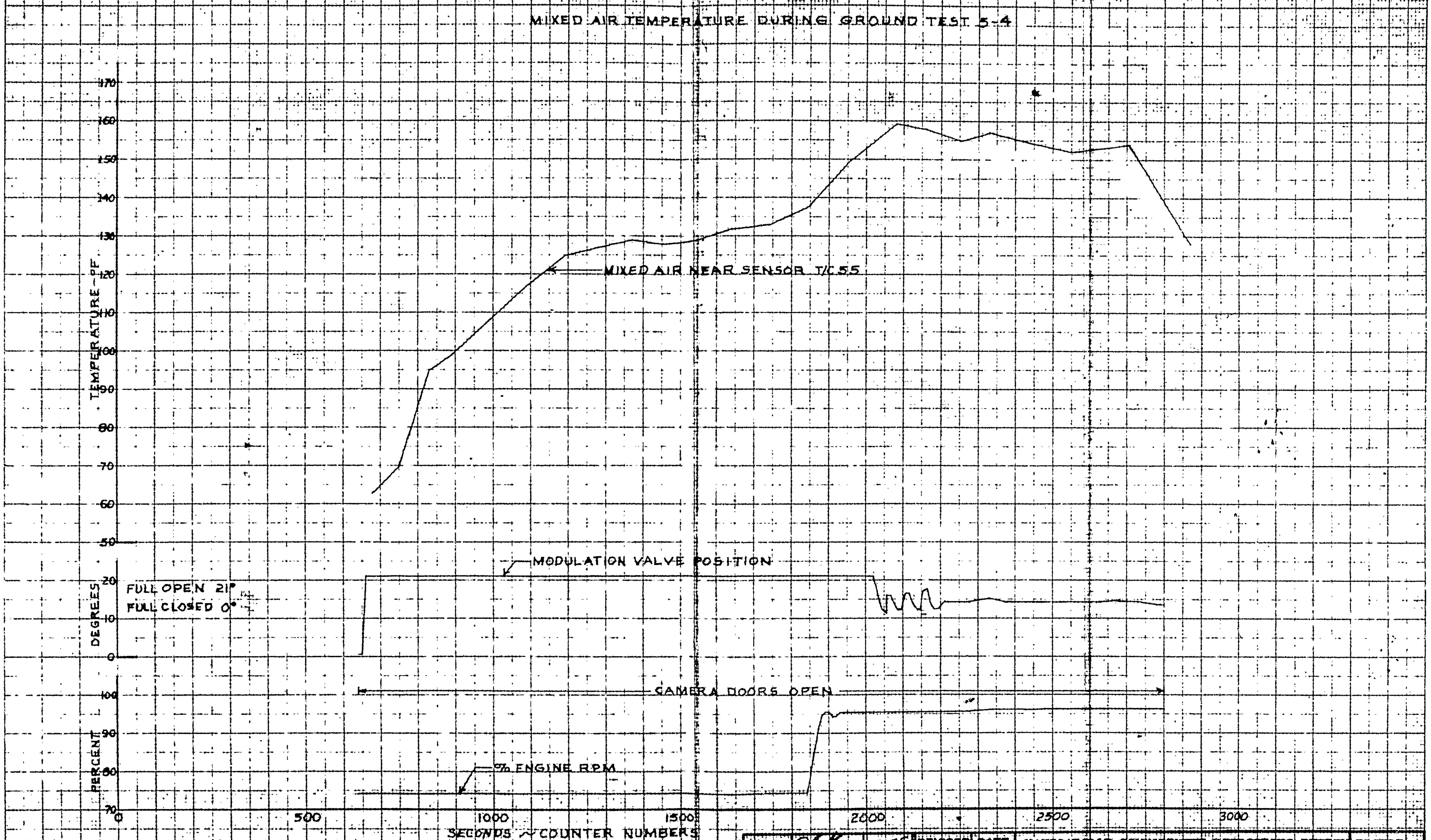
BOEING AIRPLANE COMPANY
WICHITA DIVISION — WICHITA, KANSAS

FIGURE 9
RB-47B
WD-11010
PAGE 58



CALC	OBK	10-22-55	REVISED	DATE	ATMOSPHERIC CONDITIONS IN VICINITY OF FLIGHT TEST DESCENTS	FIGURE 10
CHECK						
APR					BOEING AIRPLANE COMPANY WICHITA 1, KANSAS	WD-1[illegible]
APR						PAGE 59 OF

CONTRACT NO.



CALC	OSK	5-55	REVISED	DATE	NAVIGATOR'S COMPARTMENT DEFROSTING SYSTEM PERFORMANCE - GROUND TEST 5-4	FIGURE 11
CHECK	M. PECHT	7-55				RB-47E
APR					BOEING AIRPLANE COMPANY WICHITA, KANSAS	WD-14018
APR						PAGE 60

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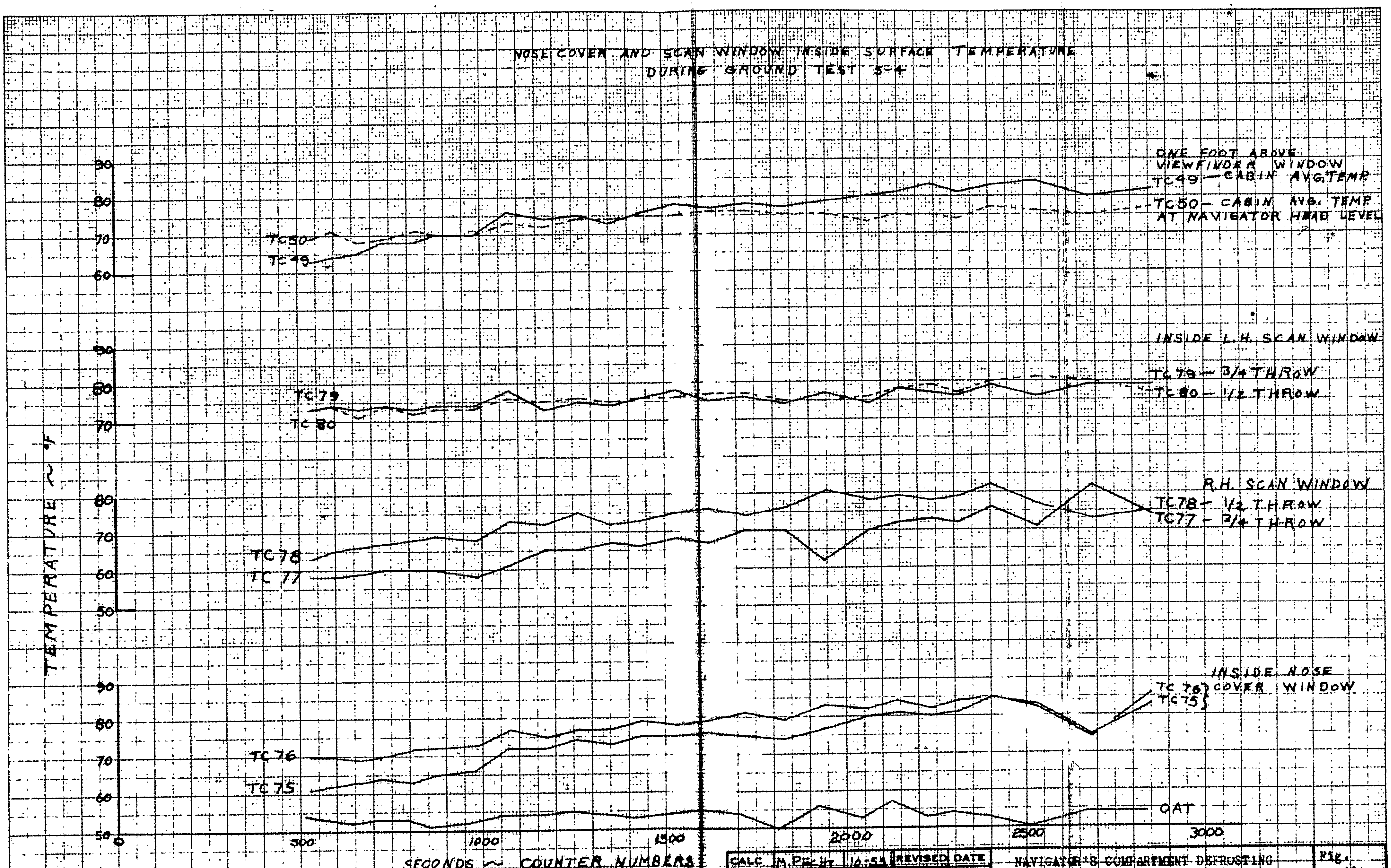
E-1201



CALC	M. Pe...Ht	10-55	REVISED	DATE
CHECK	[illegible]	10-11-55		
APR				
APR				

NAVIGATOR'S COMPARTMENT DEFROSTING SYSTEM PERFORMANCE-WINDOW INSIDE SURFACE TEMPERATURES - GROUND TEST 5-4

BOEING AIRPLANE COMPANY
WICHITA, KANSAS

Fig. 11a
RB-47E
WD-11018
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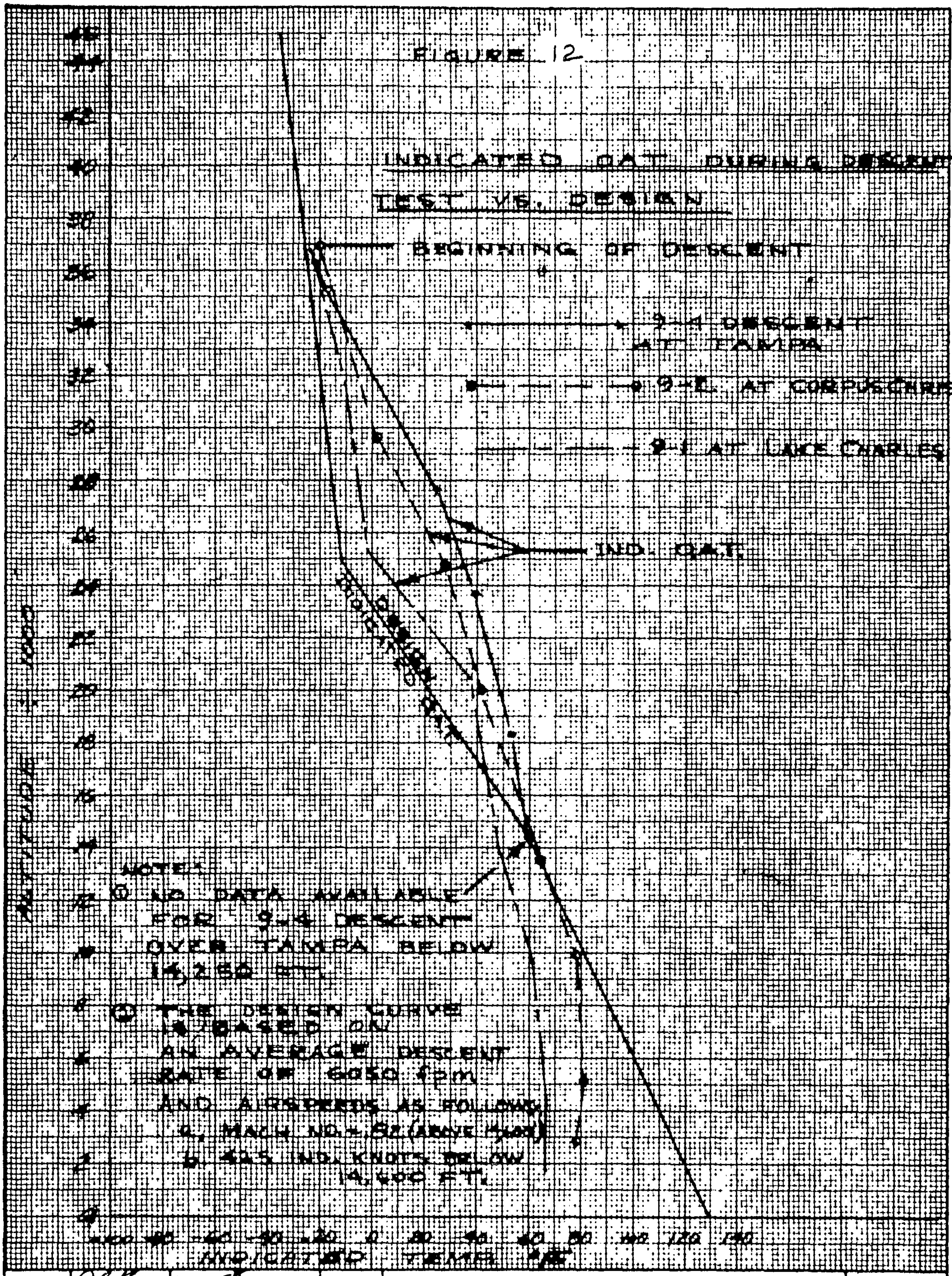
OF

CONTRACT NO.

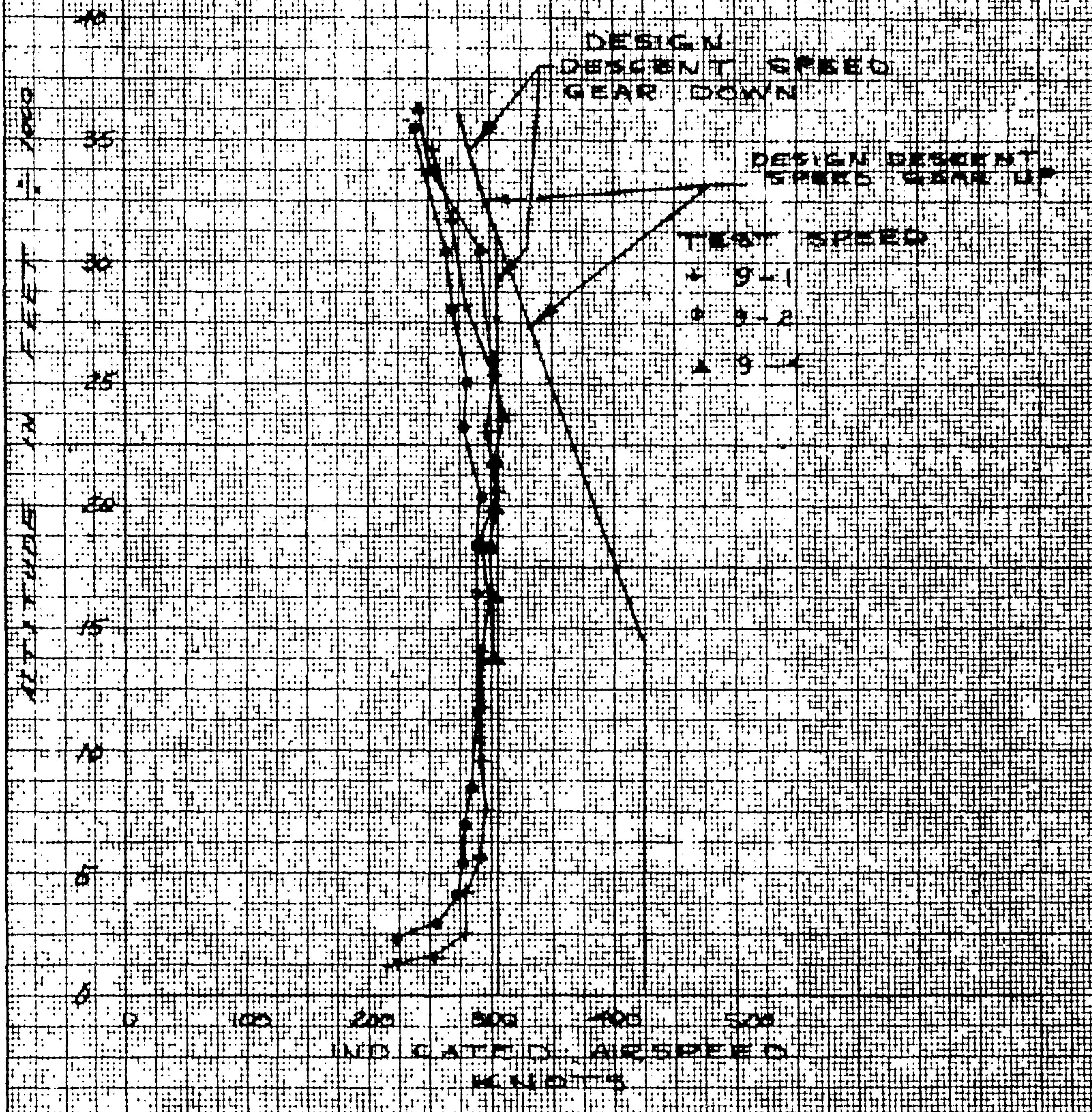
E.1281



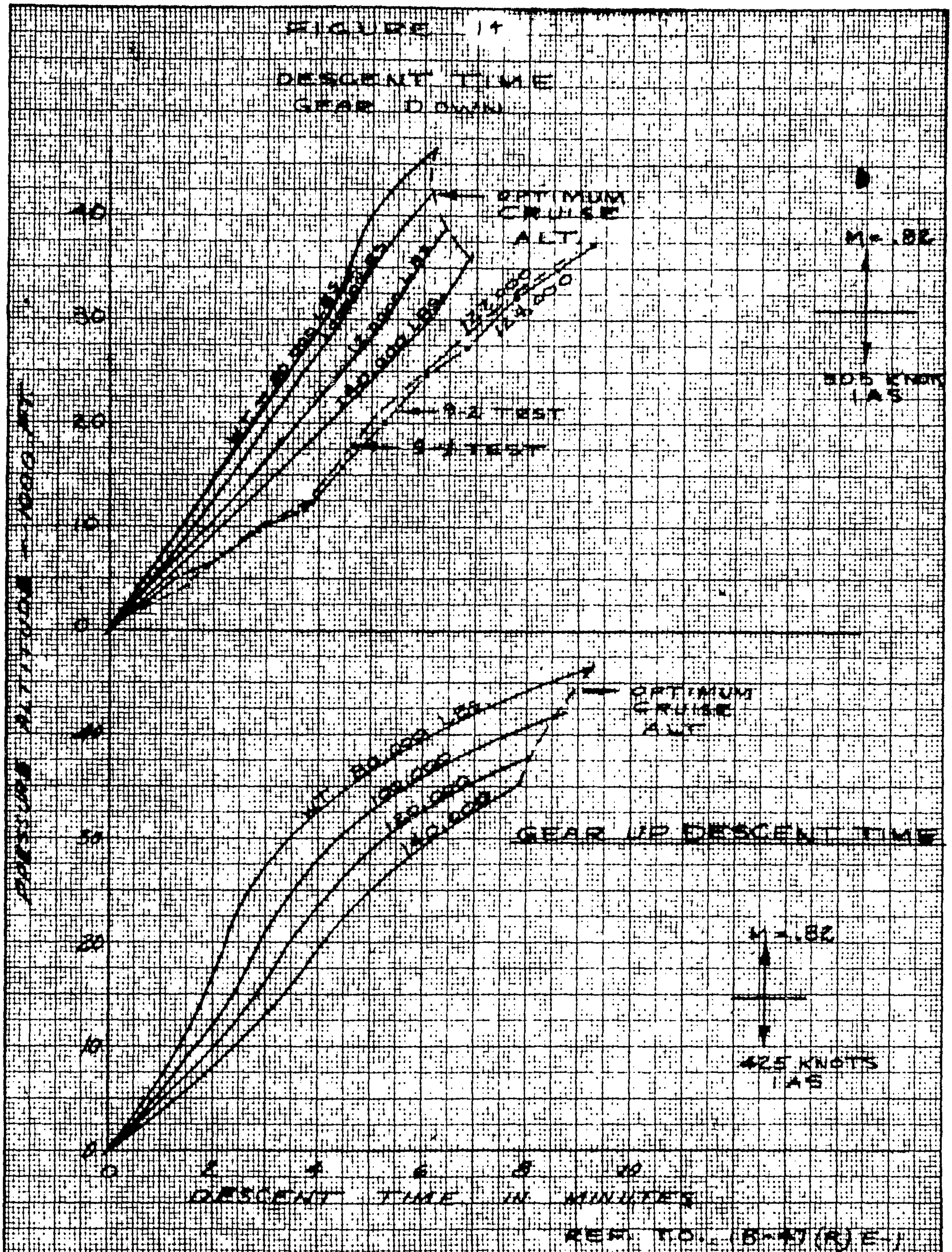
CALC	JBR	10-22-55	REVISED	DATE	INDICATED OAT DURING DESCENT TEST VS. DESIGN	FIGURE 12
CHECK						RB-47E
APR					BOEING AIRPLANE COMPANY WICHITA 1, KANSAS	WD-14018
APR						PAGE 62 OF
CONTRACT NO.						

FIGURE 13

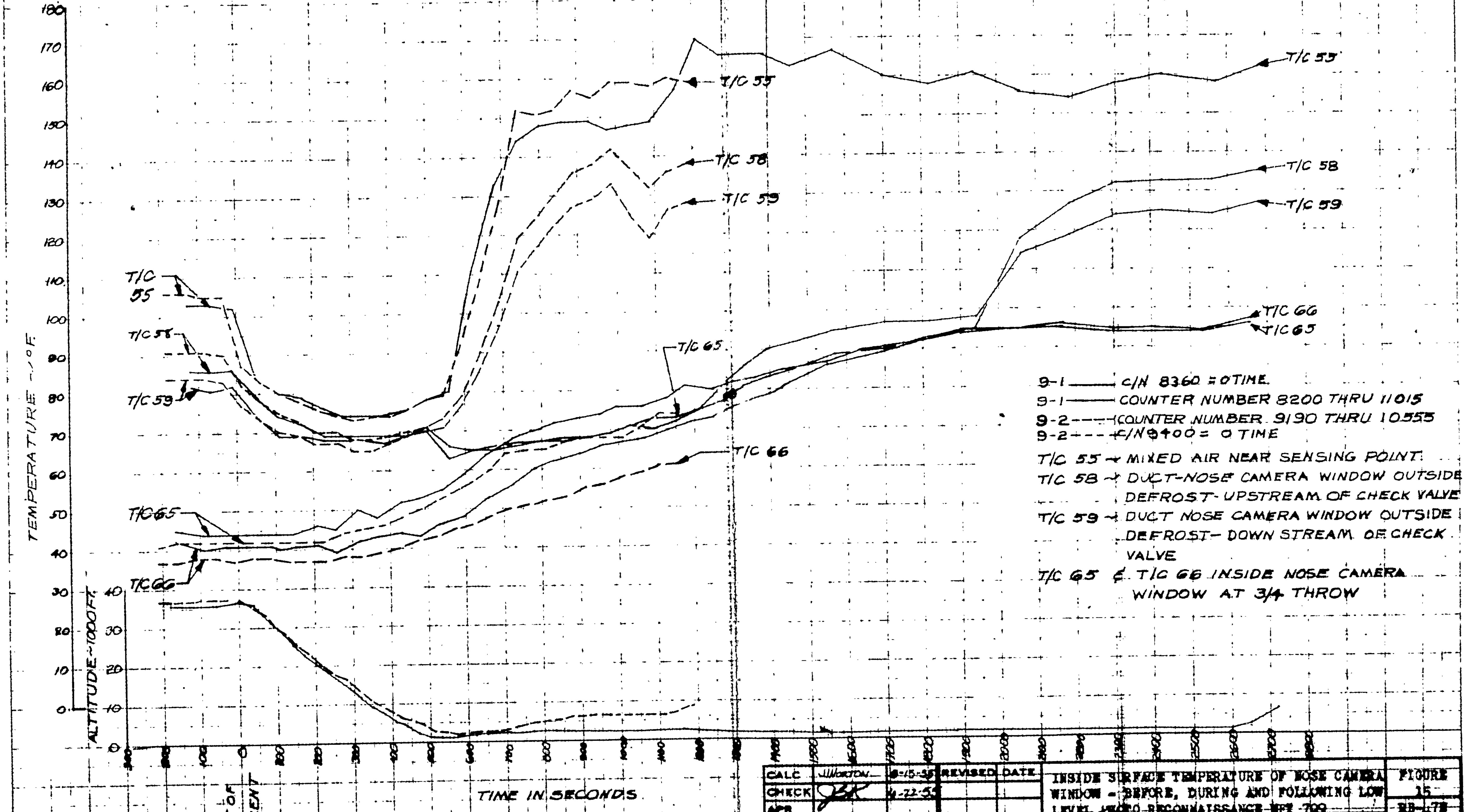
DESIGN & TEST DESCENT SPEEDS



CALC	JBK	10-22-55	REVISED	DATE	DESIGN & TEST DESCENT SPEEDS	FIGURE 13
CHECK						
APR						RB-47E
APR					BOEING AIRPLANE COMPANY WICHITA 1, KANSAS	WD-14018
						PAGE 63 OF
CONTRACT NO.						

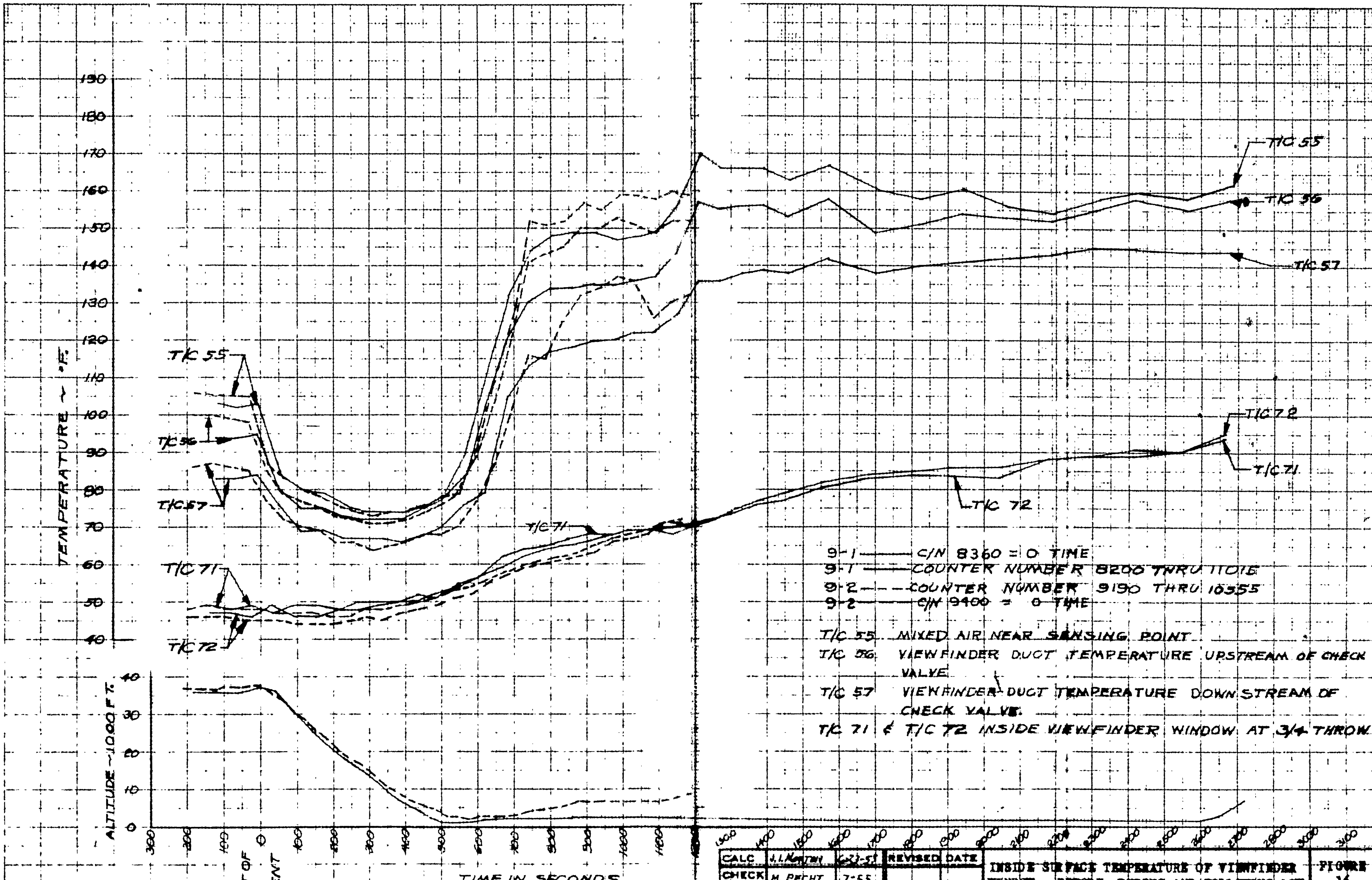


CALC		10-22-55	REVISED	DATE	DESCENT TIME	FIGURE 14
CHECK						
APR						RB-47E
APR					BOEING AIRPLANE COMPANY WICHITA 1, KANSAS	WD-14018
						PAGE 64 OF
CONTRACT NO.						



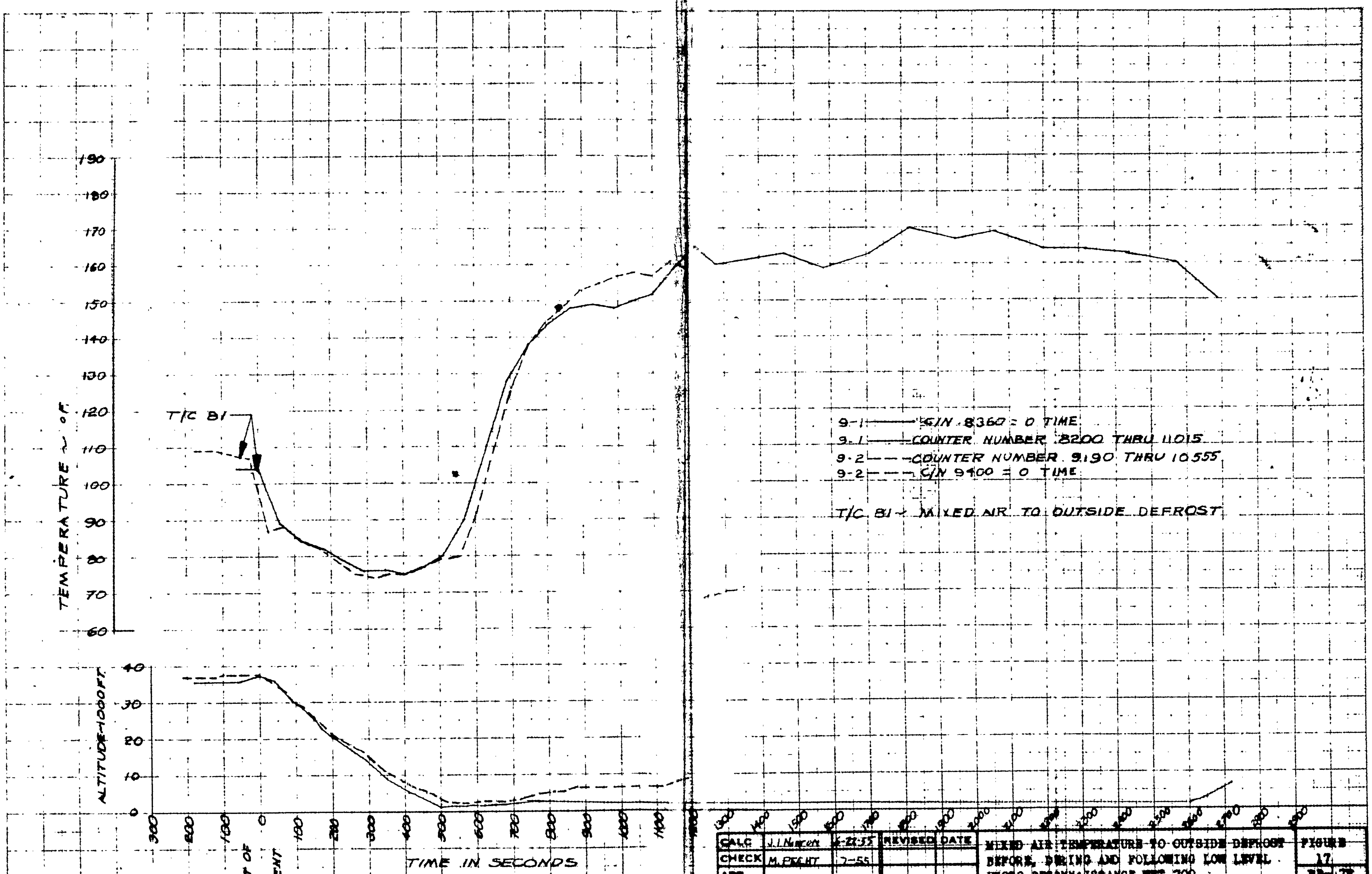
CALC	J.Wharton	9-15-55	REVISED	DATE	INSIDE SURFACE TEMPERATURE OF NOSE CAMERA WINDOW - BEFORE, DURING AND FOLLOWING LOW LEVEL PHOTO RECONNAISSANCE RUN 709	FIGURE 15
CHECK		4-22-55				RB-47B
APR					BOEING AIRPLANE COMPANY	MD-14018
APR					WICHITA, KANSAS	PAGE 65 OF

CONTRACT NO.



			REVISED	DATE		
CALC	J.I. Martin	6-23-57			INSIDE SURFACE TEMPERATURE OF VIEWFINDER WINDOW - BEFORE, DURING AND FOLLOWING LOW LEVEL PHOTO RECONNAISSANCE FLT 700	FIGURE 16
CHECK	M. PECHT	7-55				RB-47E
APR					BOEING AIRPLANE COMPANY WICHITA, KANSAS	WD-11018
APR						PAGE 66 OF

CONTRACT NO.



CALC	J.I.Nacon	6-22-55	REVISED	DATE
CHECK	M. PECHT	7-55		
APR				
APR				

MIXED AIR TEMPERATURE TO OUTSIDE DEFROST BEFORE, DURING AND FOLLOWING LOW LEVEL PHOTO RECONNAISSANCE NFT 700

BOEING AIRPLANE COMPANY
WICHITA, KANSAS

FIGURE 17

RB-47E

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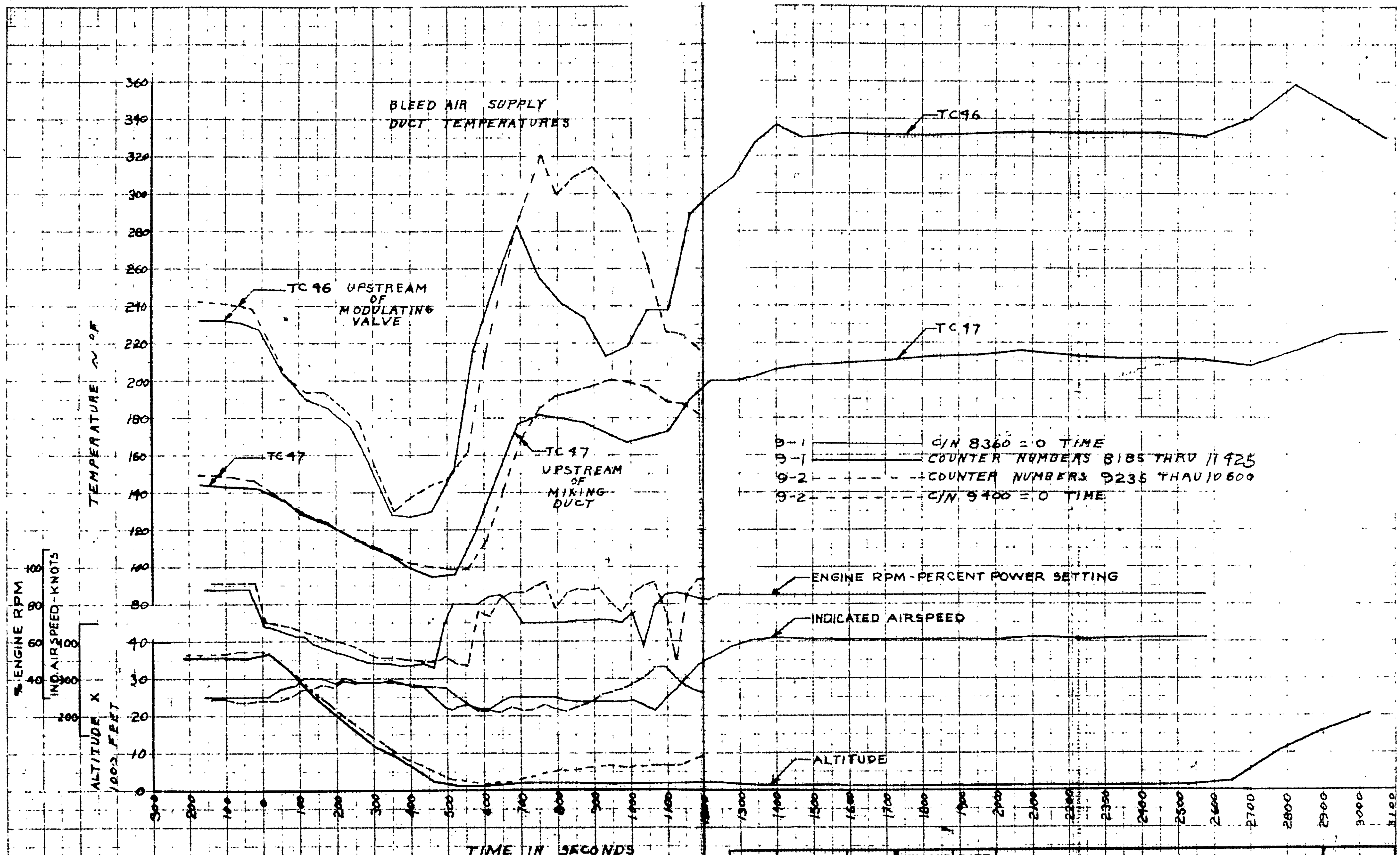

CALC	M. F. ...	6-...	REVISED	DATE
CHECK	JSK	10-22-58		
APR				
APR				

BLEED AIR SUPPLY TEMPERATURES - BEFORE, DURING, AND FOLLOWING LOW LEVEL PHOTO RECONNAISSANCE MFT 709

BOEING AIRPLANE COMPANY
WICHITA, KANSAS

FIGURE 18

RB-47E

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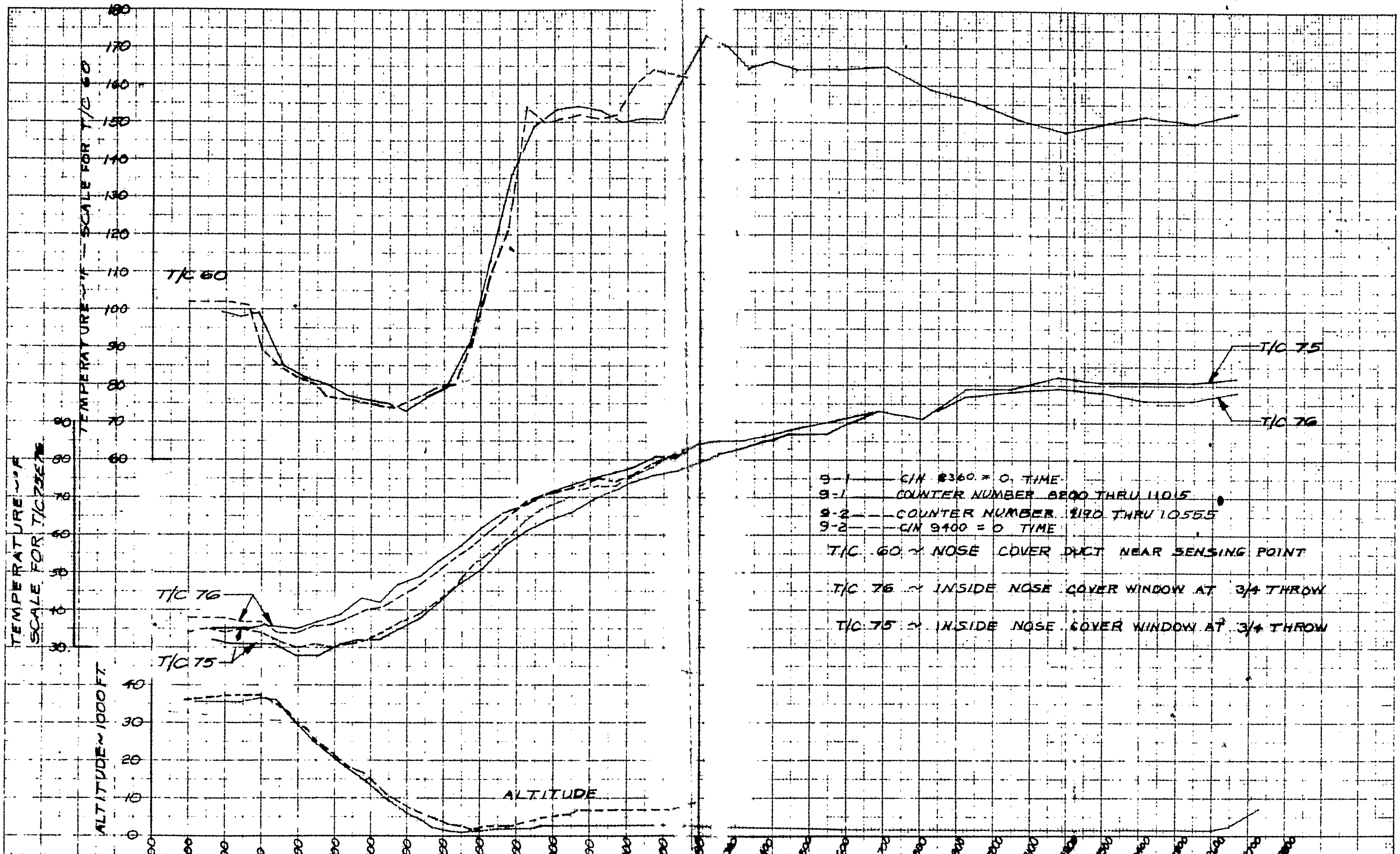
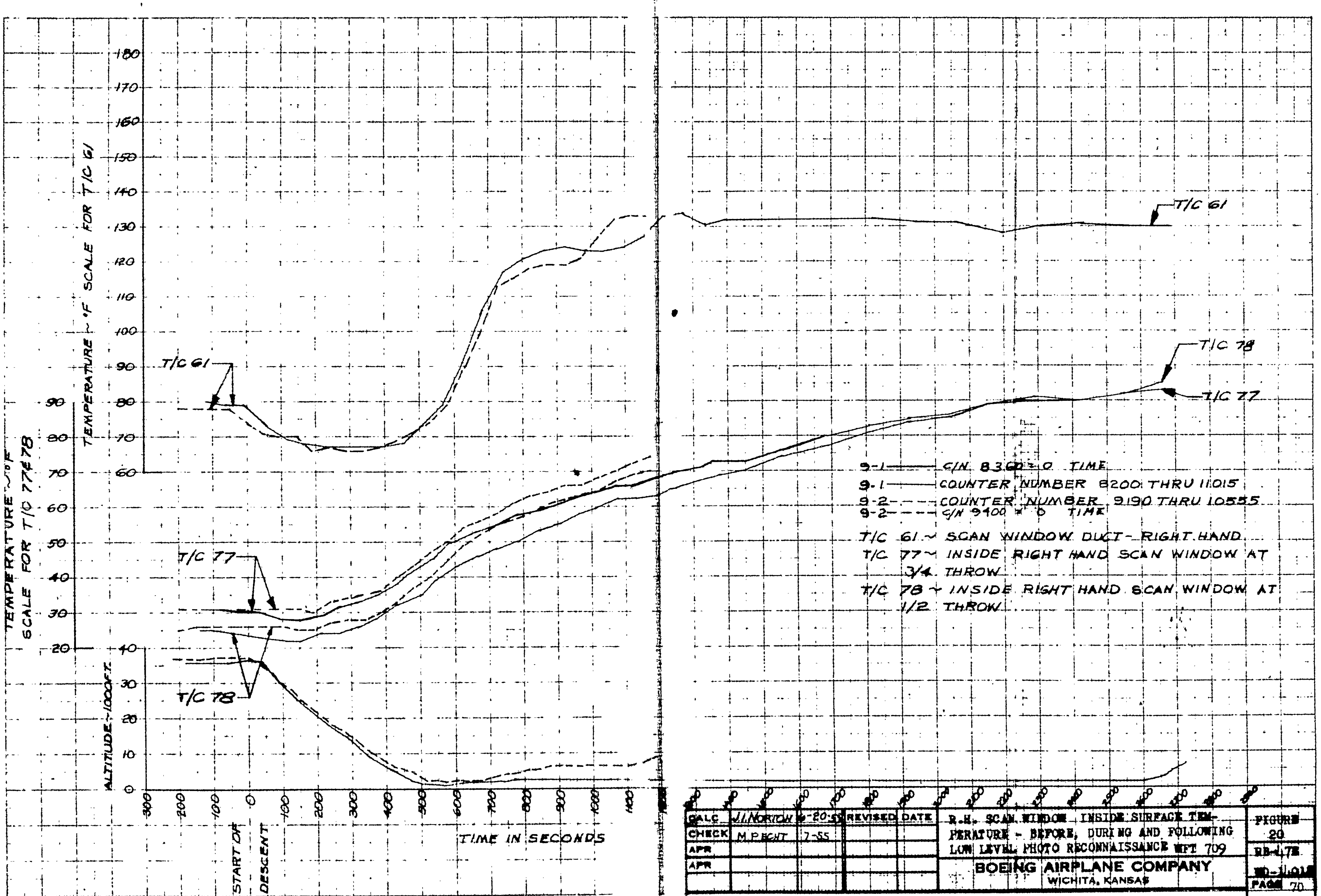


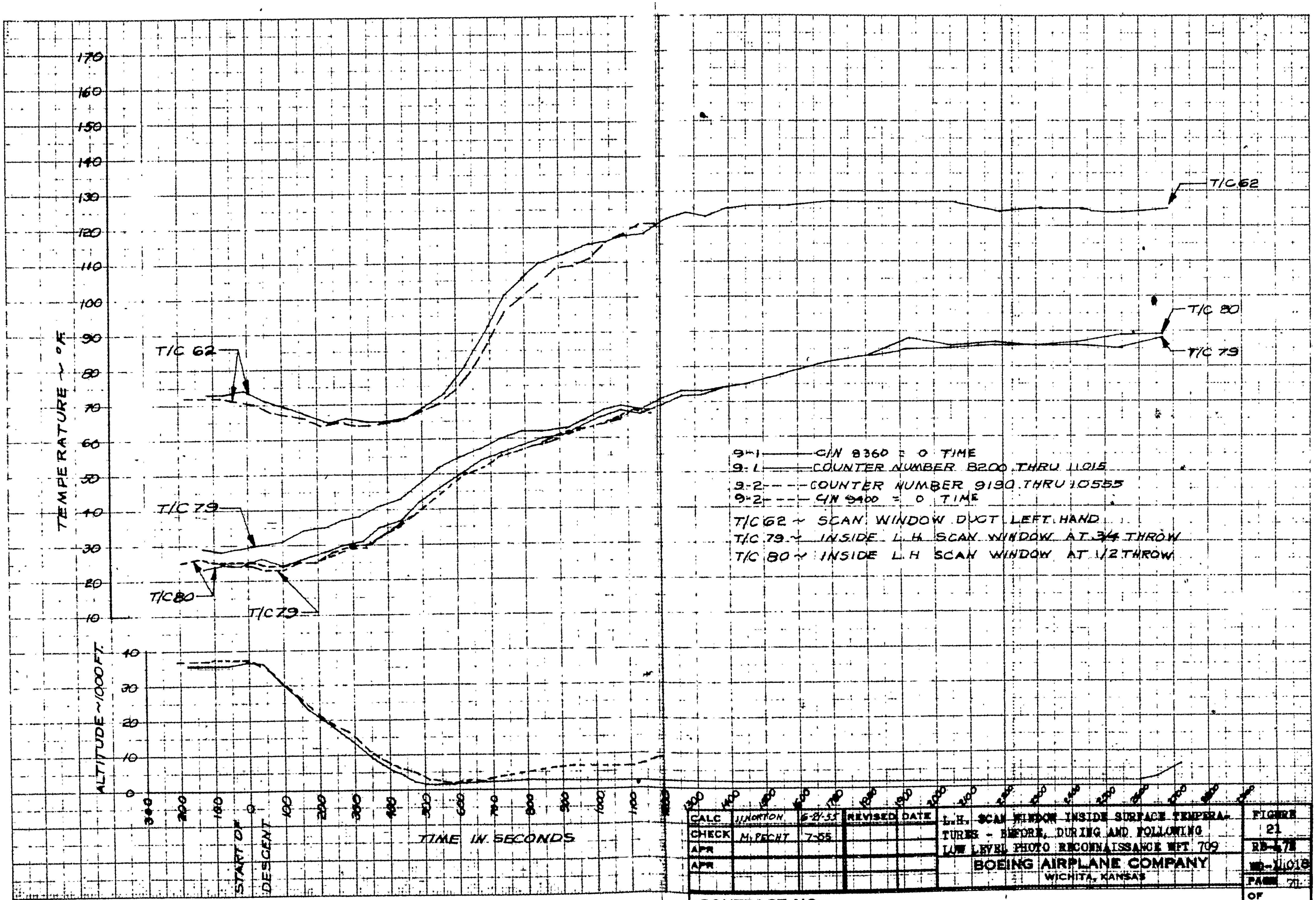
CALC	J.I. NORTON	6-17-55	REVISED	DATE	NOSE COVER WINDOW INSIDE SURFACE TEMPERATURES - BEFORE, DURING AND FOLLOWING LOW LEVEL PHOTO RECONNAISSANCE FLT 709	FIGURE 19
CHECK	M. PECHT	7-55				RB-47E
APR					BOEING AIRPLANE COMPANY	D-14018
APR					WICHITA, KANSAS	PAGE 69 OF

CONTRACT NO.



CALC	J.I.NORTON	6-20-55	REVISED	DATE	R.H. SCAN WINDOW INSIDE SURFACE TEMPERATURE - BEFORE, DURING AND FOLLOWING LOW LEVEL PHOTO RECONNAISSANCE WFT 709	FIGURE 20
CHECK	M.PECHT	7-55				RB-47E
APR					BOEING AIRPLANE COMPANY WICHITA, KANSAS	WD-11015
APR						PAGE 70 OF

CONTRACT NO.



CALC	J.J.NORTON	6-21-55	REVISED	DATE
CHECK	M. PECHT	7-55		
APR				
APR				

L.H. SCAN WINDOW INSIDE SURFACE TEMPERATURES - BEFORE, DURING AND FOLLOWING LOW LEVEL PHOTO RECONNAISSANCE WFT 709

BOEING AIRPLANE COMPANY
WICHITA, KANSAS

FIGURE 21

RB-47E

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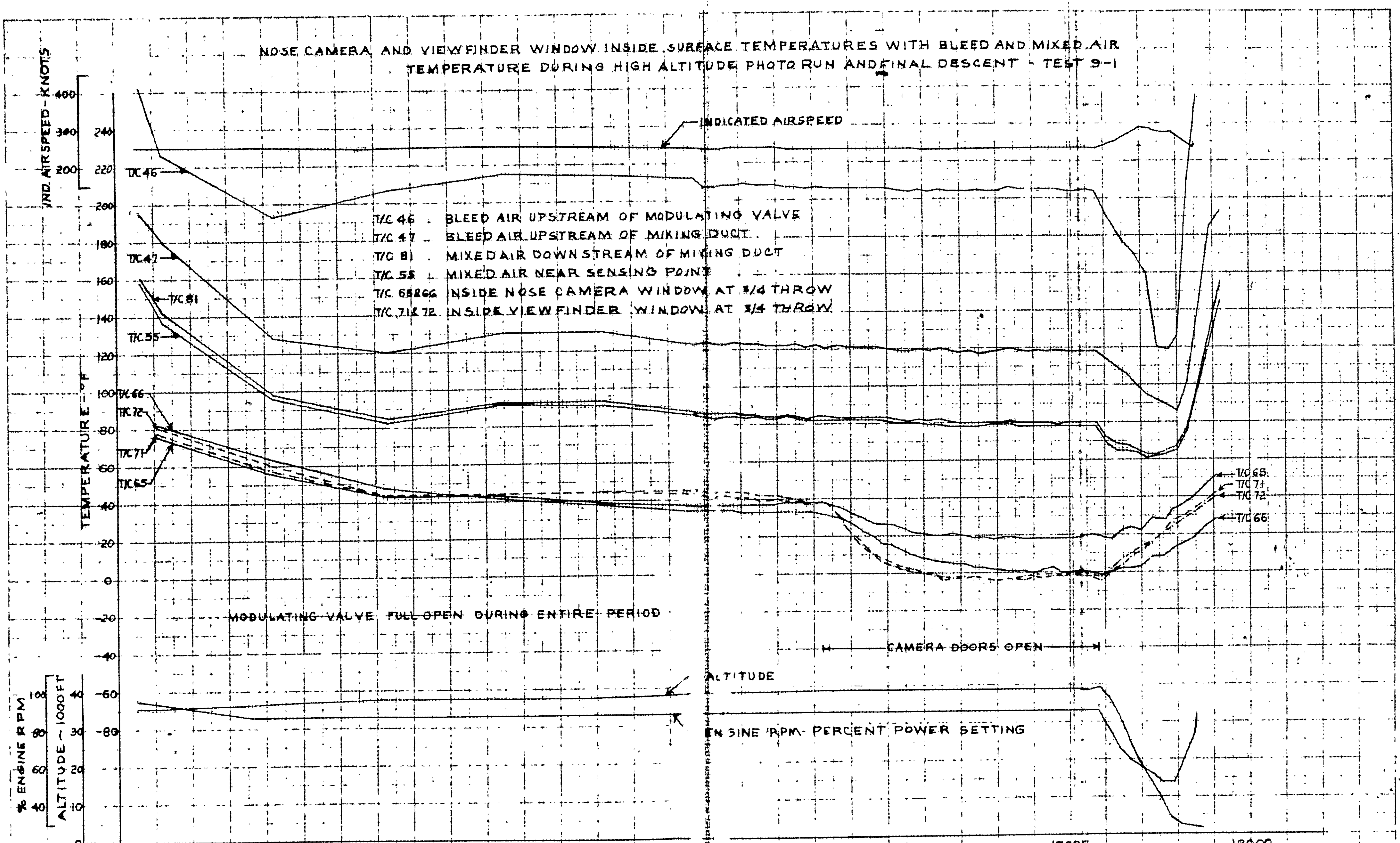

CALC	DJK	10-22-55	REVISED	DATE	NOSE CAMERA AND VIEWFINDER INSIDE SURFACE TEMPERATURES DURING HIGH ALTITUDE PHOTO RECONNAISSANCE WFT 709-TEST 9-1	FIGURE 22
CHECK						RB-47E
APR					BOEING AIRPLANE COMPANY WICHITA 1, KANSAS	MD-11018
APR						PAGE 72 OF

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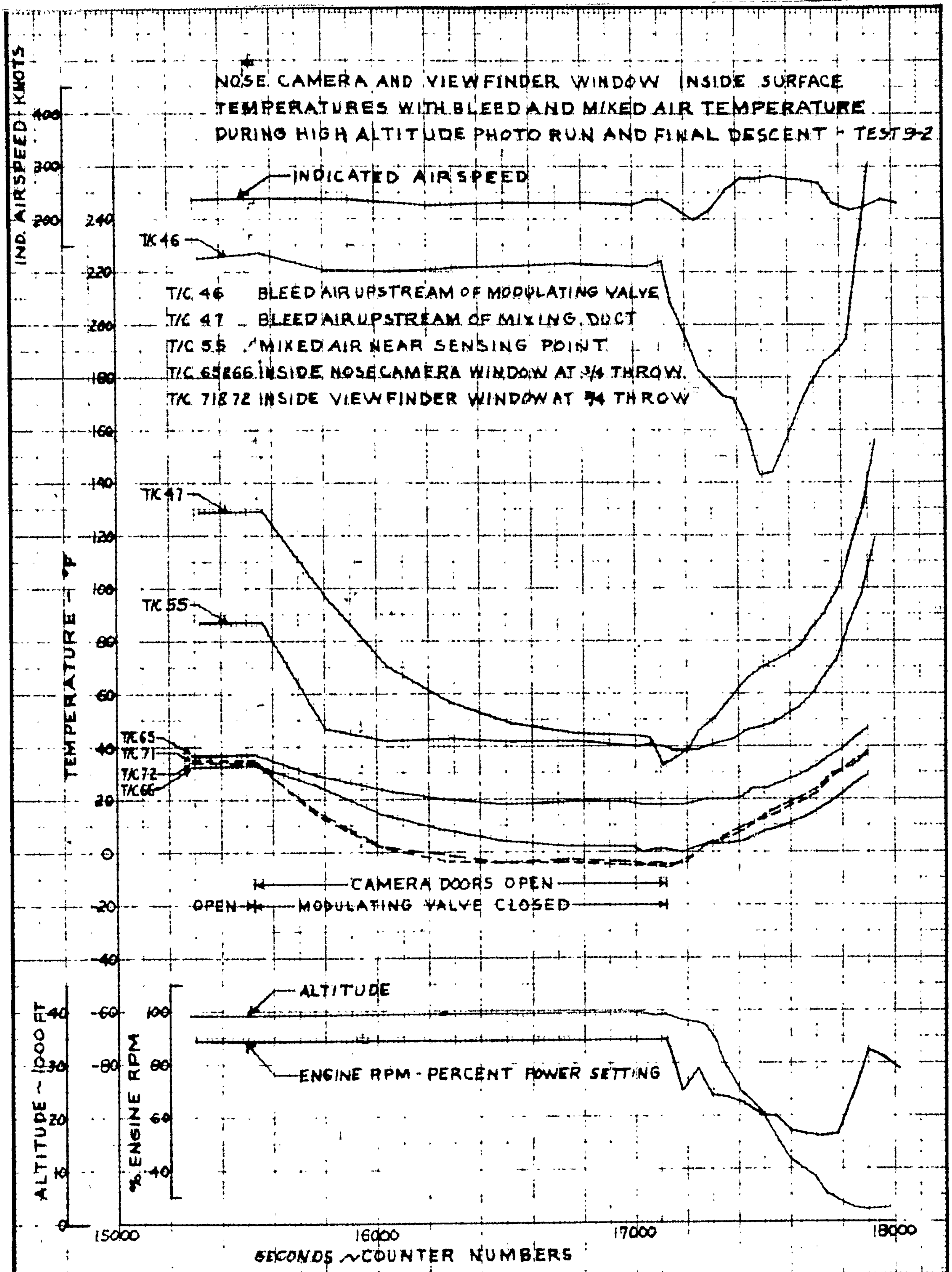
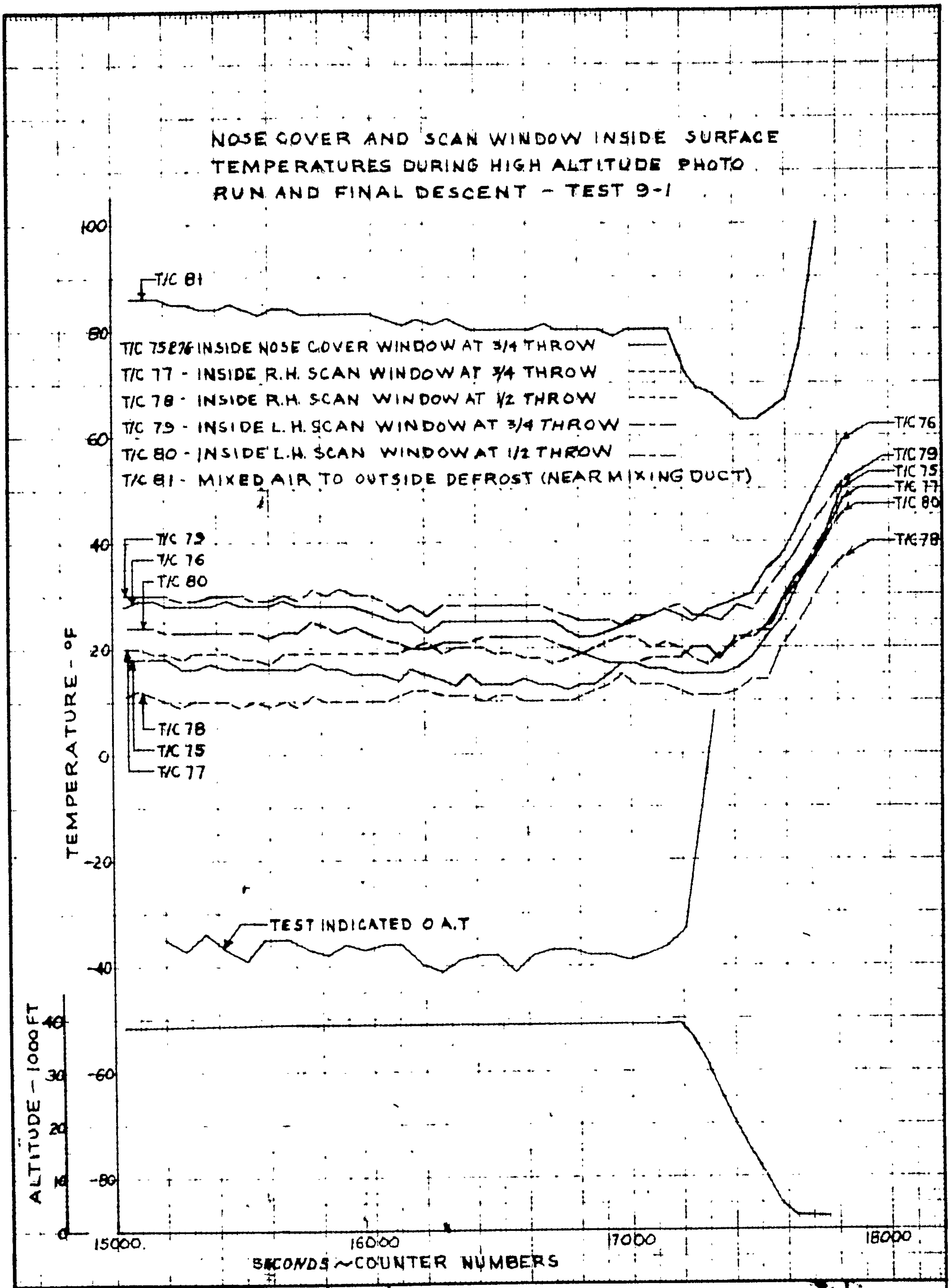


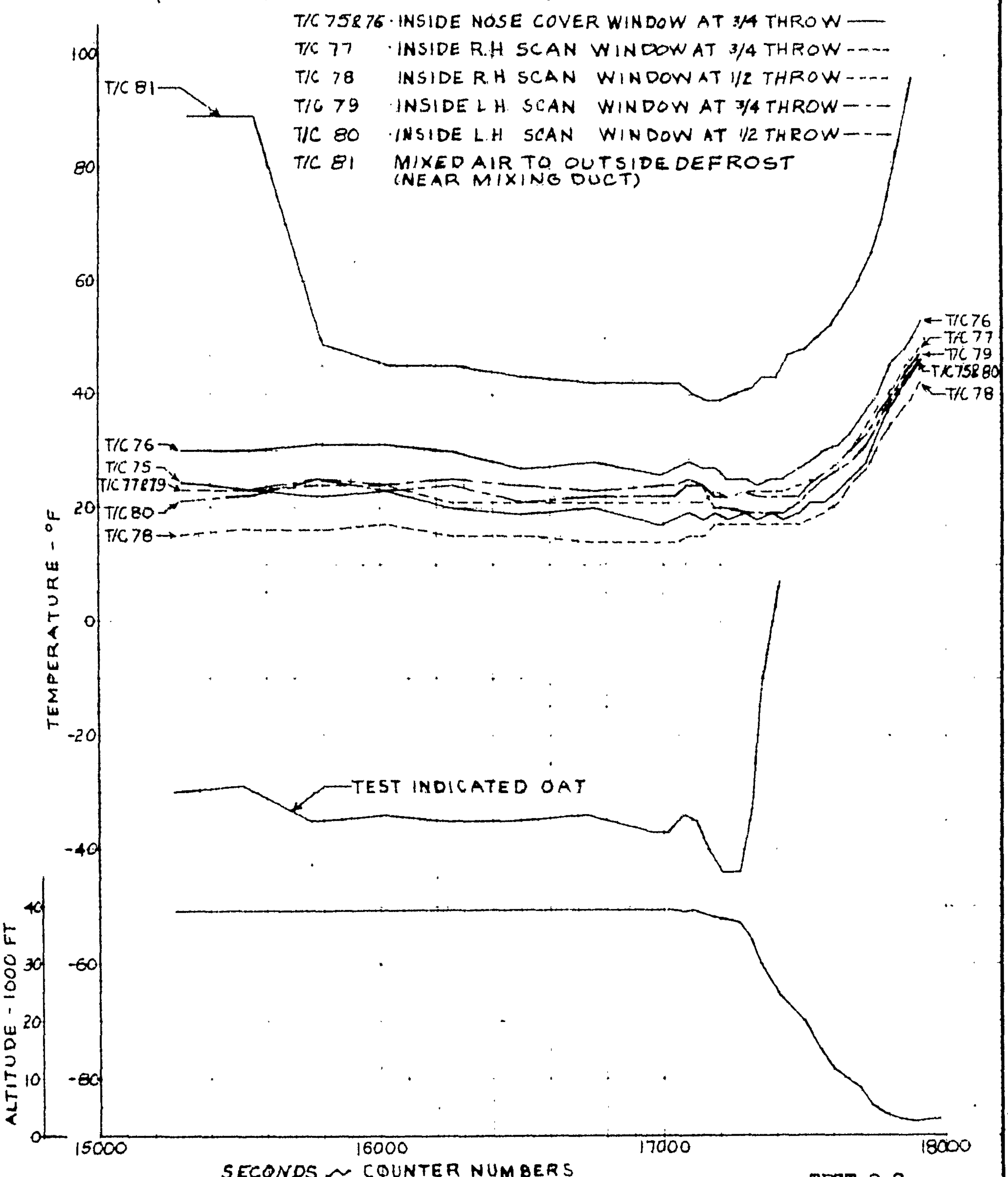
CALC		10-22-55	REVISED	DATE	NOSE CAMERA AND VIEWFINDER INSIDE SURFACE TEMPERATURES DURING HIGH ALTITUDE PHOTO RECONNAISSANCE-WFT709 TEST 9-2	FIGURE 23
CHECK						RB-47E
APR					BOEING AIRPLANE COMPANY WICHITA 1, KANSAS	WD-14018
APR						PAGE 73
CONTRACT NO.						OF



CALC	JEK	6-22-55	REVISED	DATE	NOSE COVER AND SCAN WINDOW INSIDE SURFACE TEMPERATURES DURING HIGH ALTITUDE PHOTO RECONNAISSANCE-WFT709 TEST 9-1	FIGURE 24
CHECK						RB-47E
APR					BOEING AIRPLANE COMPANY	WD-14018
APR					WICHITA 1, KANSAS	PAGE 74
						OF

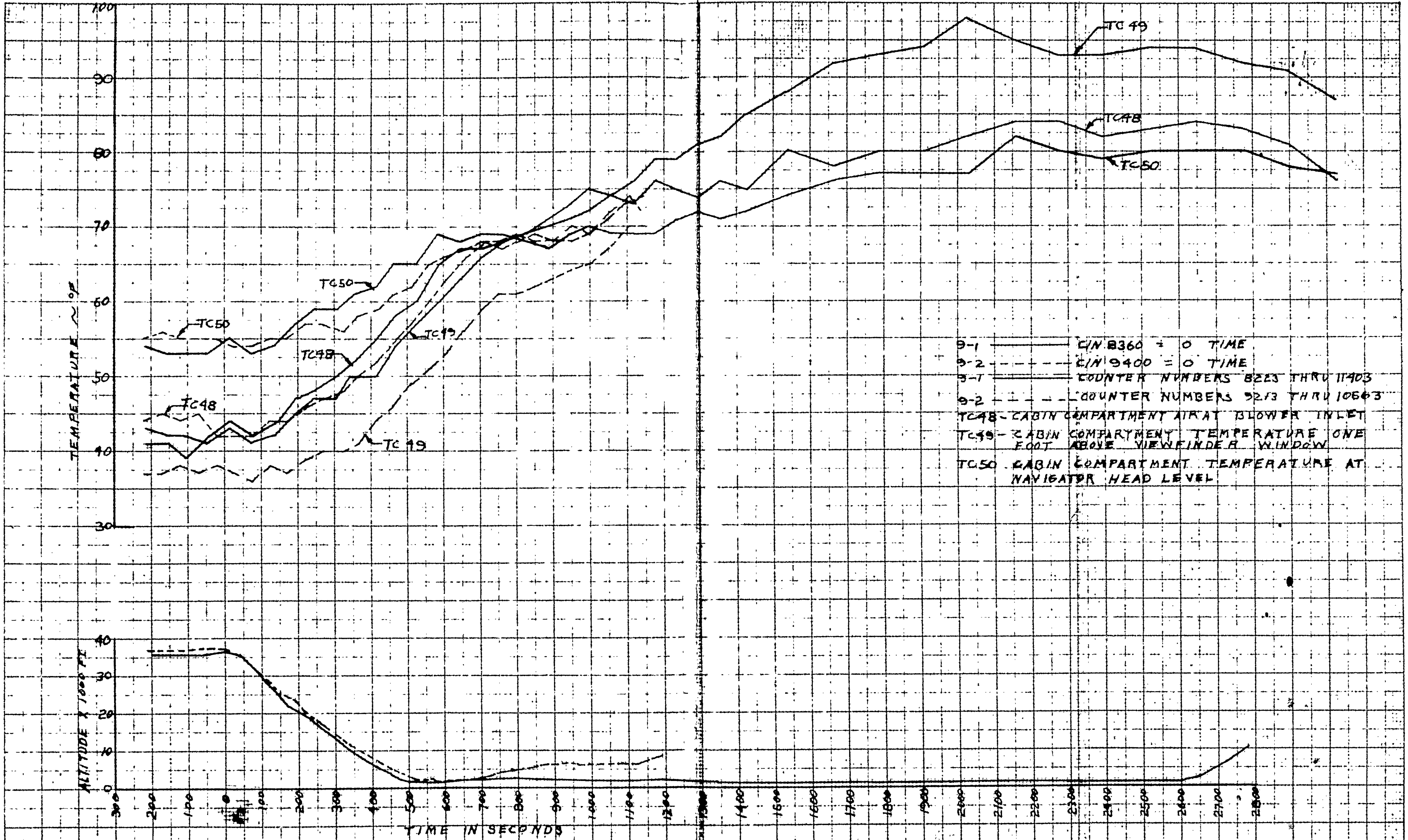
CONTRACT NO.

NOSE COVER AND SCAN WINDOW INSIDE SURFACE TEMPERATURES DURING HIGH ALTITUDE PHOTO RUN AND FINAL DESCENT - TEST 9-2



TEST 9-2

CALC	JBR	10-22-55	REVISED	DATE	NOSE COVER AND SCAN WINDOW INSIDE SURFACE TEMPERATURES DURING HIGH ALTITUDE PHOTO RECONNAISSANCE-WFT709	FIGURE 25
CHECK						RB-47E
APR					BOEING AIRPLANE COMPANY WICHITA 1, KANSAS	WD-14018
APR						PAGE 75
CONTRACT NO.						OF



CALC	M. Pehl	6-55	REVISED	DATE
CHECK	[illegible]	10-22-55		
APR				
APR				

NAVIGATOR'S COMPARTMENT TEMPERATURES - BEFORE, DURING AND FOLLOWING LOW LEVEL PHOTO RECONNAISSANCE WPT 709

BOEING AIRPLANE COMPANY
WICHITA, KANSAS

FIGURE 26

RB-47E

D-11018

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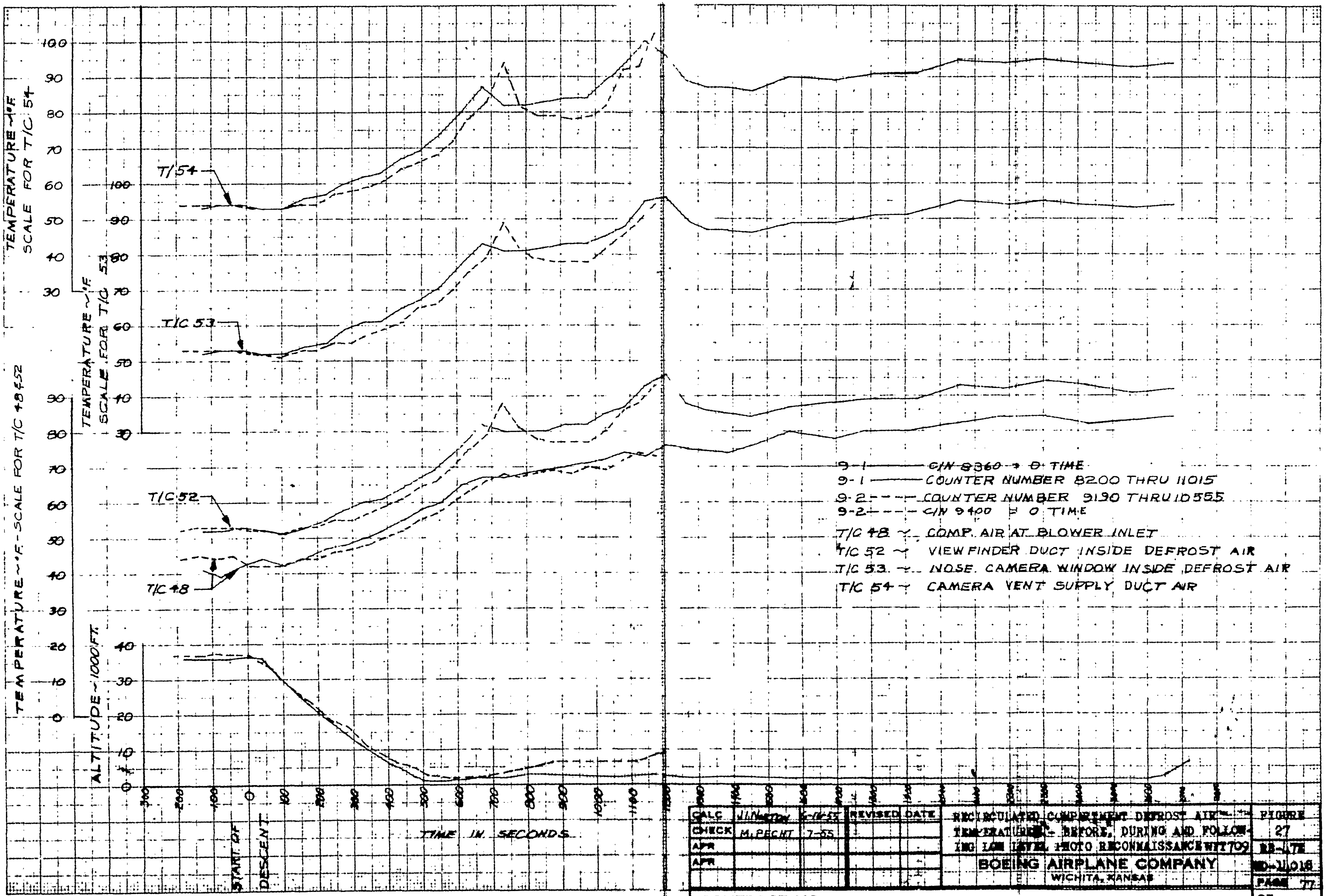

			REVISED	DATE		
CALC	J.I.Newton	6-16-55			RECIRCULATED COMPARTMENT DEFROST AIR TEMPERATURES BEFORE, DURING AND FOLLOWING LOW LEVEL PHOTO RECONNAISSANCE WT1709	FIGURE 27
CHECK	M. PECHT	7-55				RB-47E
APR					BOEING AIRPLANE COMPANY	D-11,018
APR					WICHITA, KANSAS	PAGE 77

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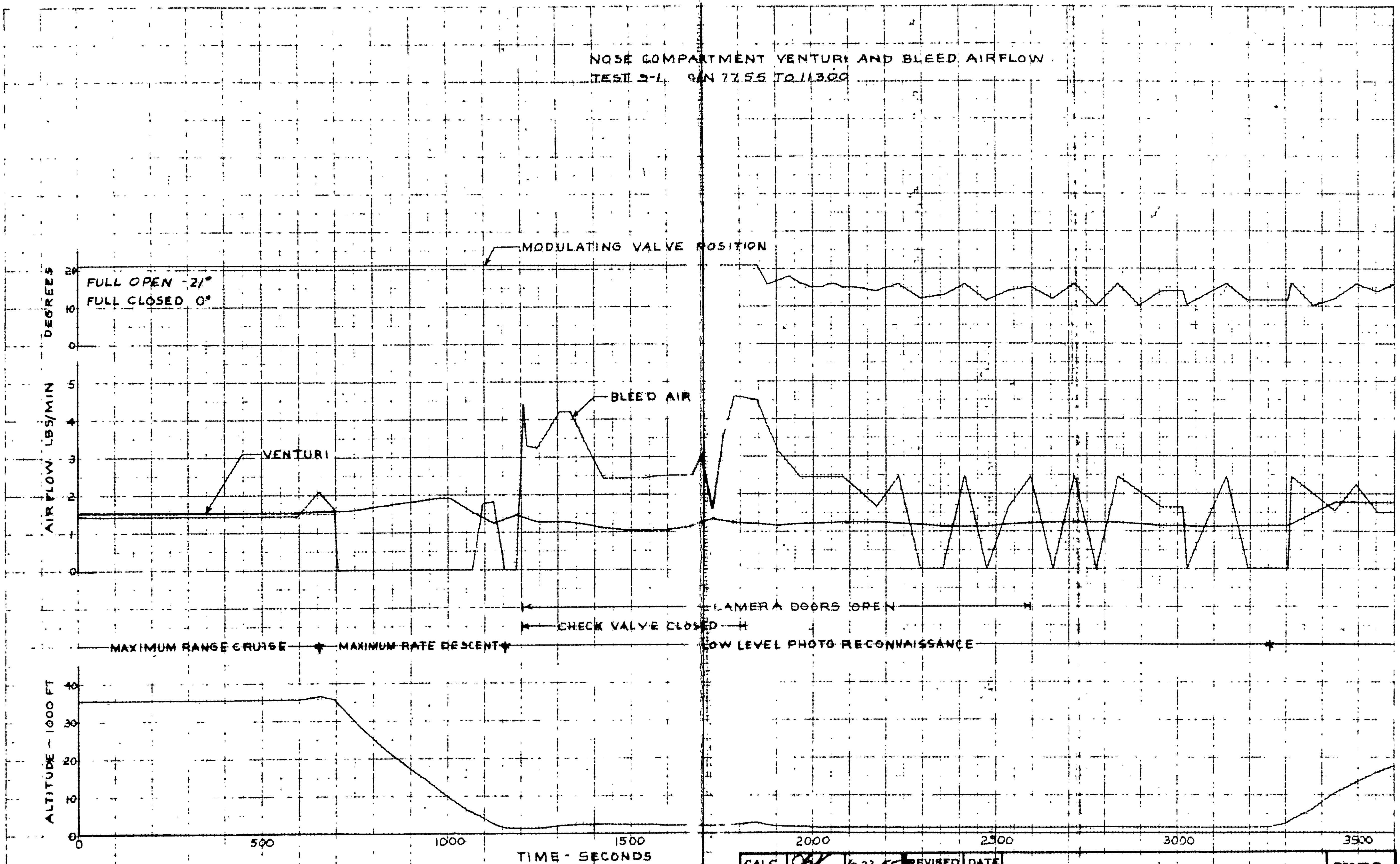
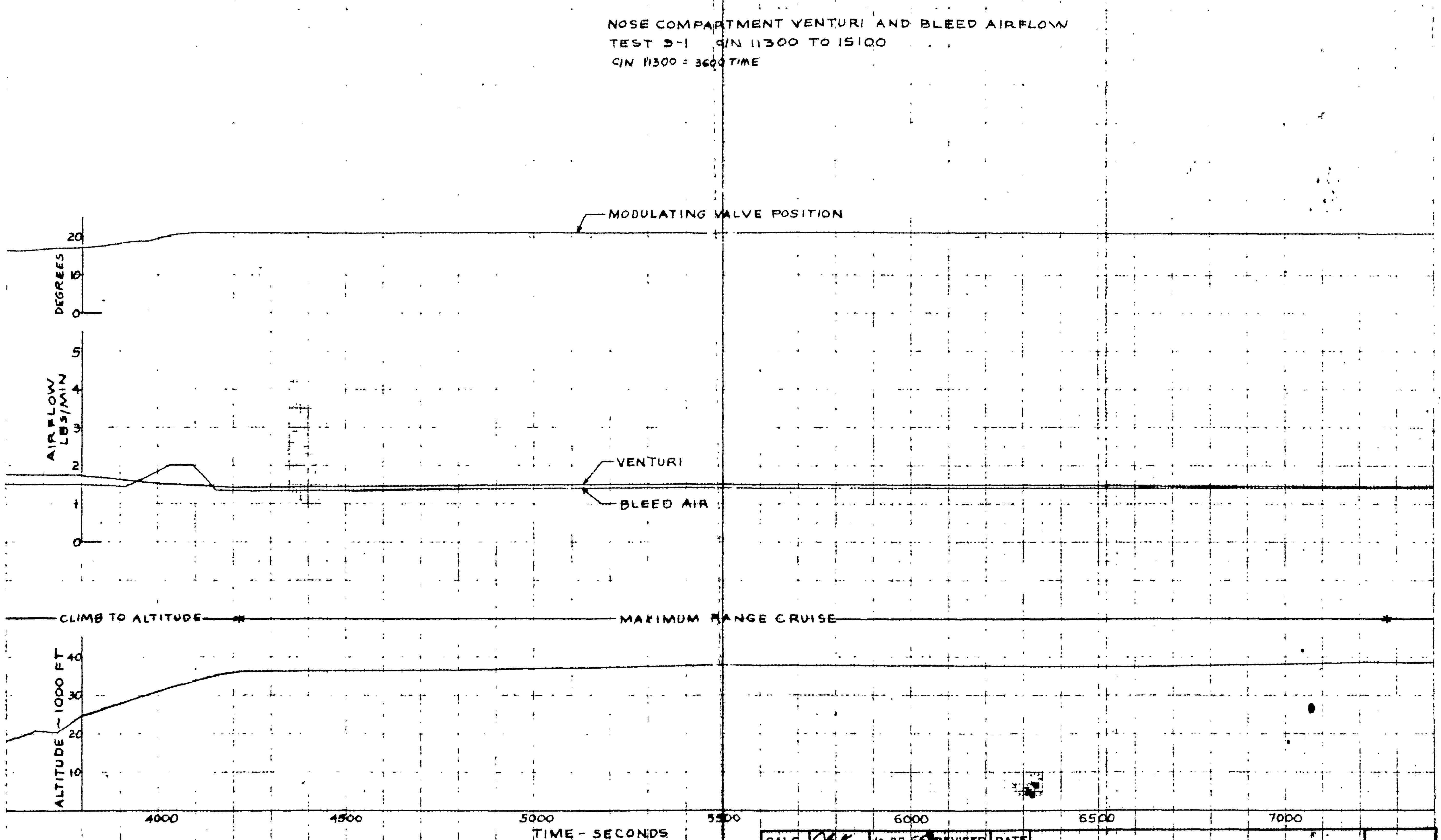


CALC	JK	10-22-55	REVISED	DATE	DEFROST SYSTEM VENTURI AND BLEED AIR FLOW WFT 709 - TEST 9-1	FIGURE 28
CHECK						RB-47E
APR					BOEING AIRPLANE COMPANY WICHITA 1, KANSAS	WD-11018
APR						PAGE 78 OF

CONTRACT NO.



CALC	JSK	10-22-56	REVISED	DATE
CHECK				
APR				
APR				

DEFROST SYSTEM VENTURI AND BLEED AIR FLOW WPT 709 - TEST 9-1

BOEING AIRPLANE COMPANY
WICHITA 1, KANSAS

CONTRACT NO.

FIGURE 29

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WD-14018

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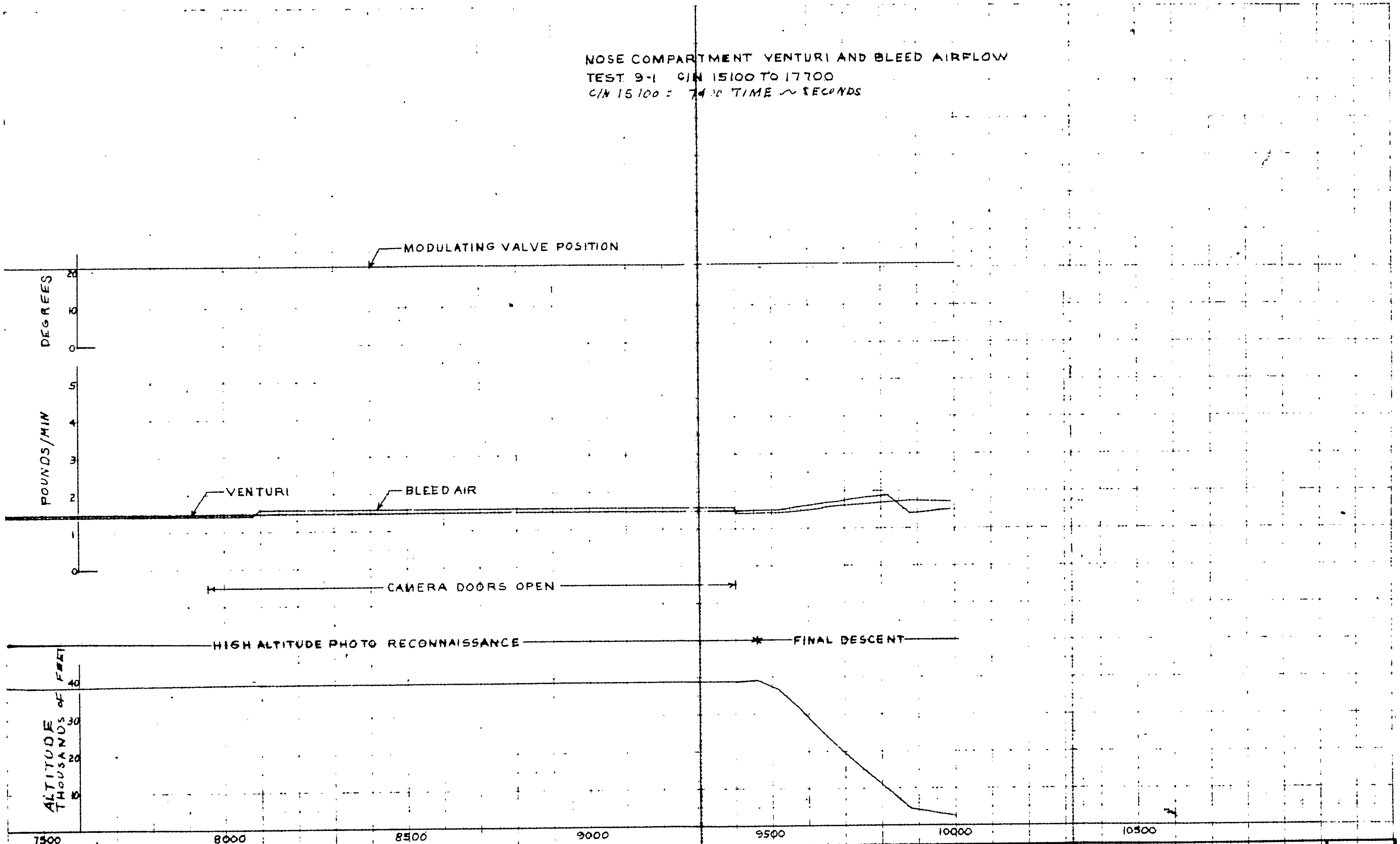
OF



CALC	10-12-55	REVISED	DATE	DEFROST SYSTEM VENTURI AND BLEED AIR FLOW WRT 709 - TEST 9-1	FIGURE 30
CHECK					RD-478
APR				BOEING AIRPLANE COMPANY WICHITA 1, KANSAS	RD-11,018
APR					PAGE 80 OF

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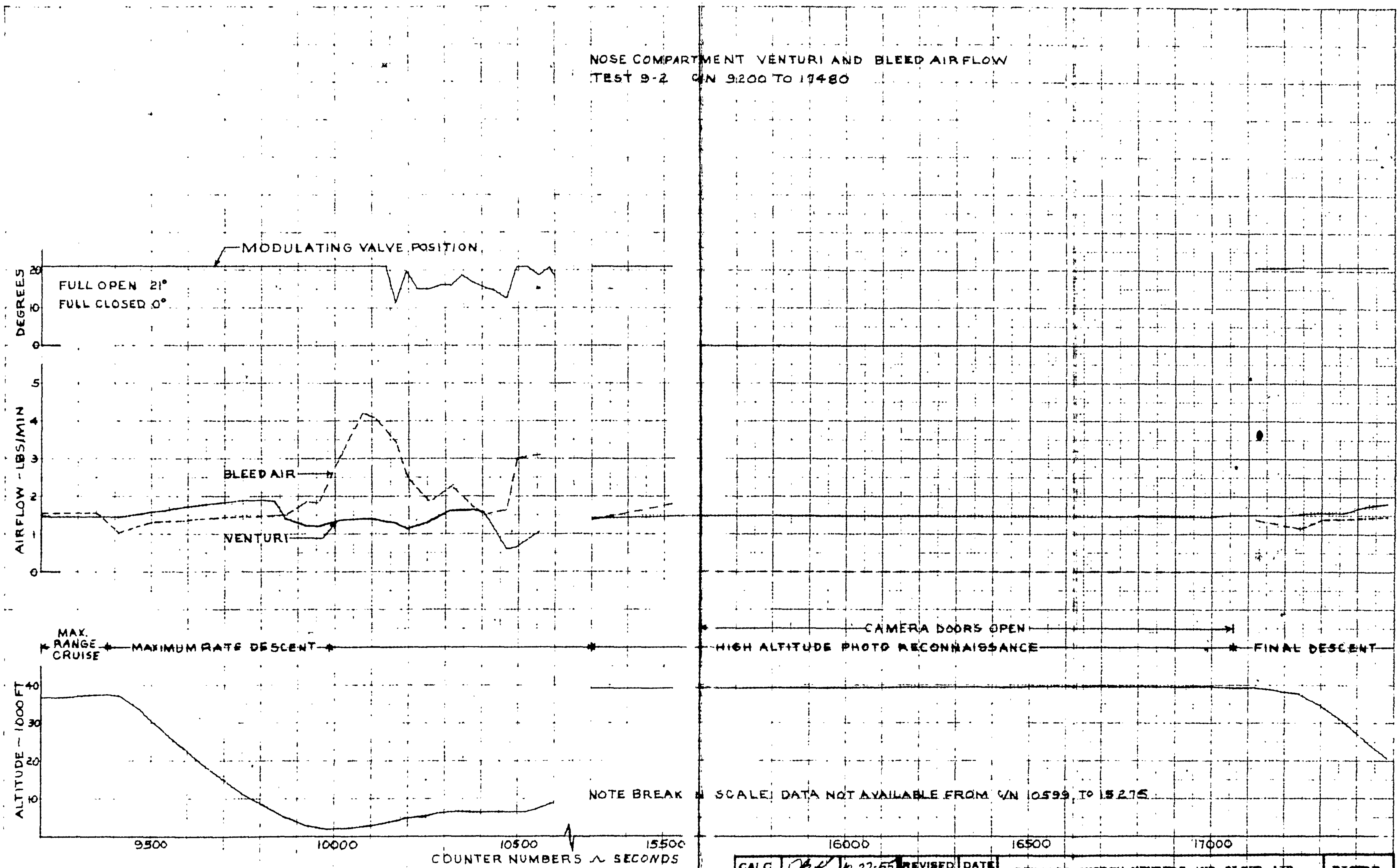
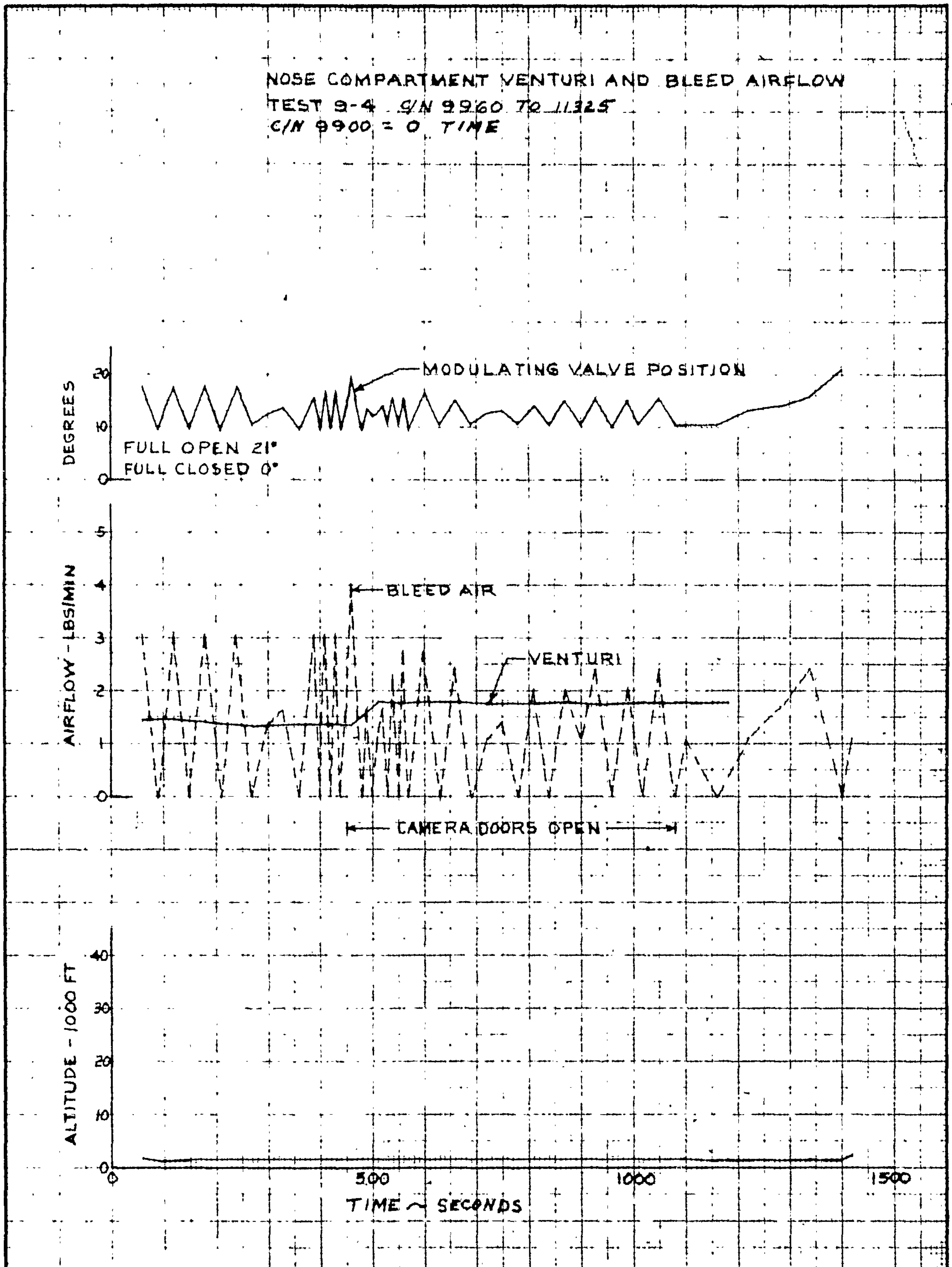
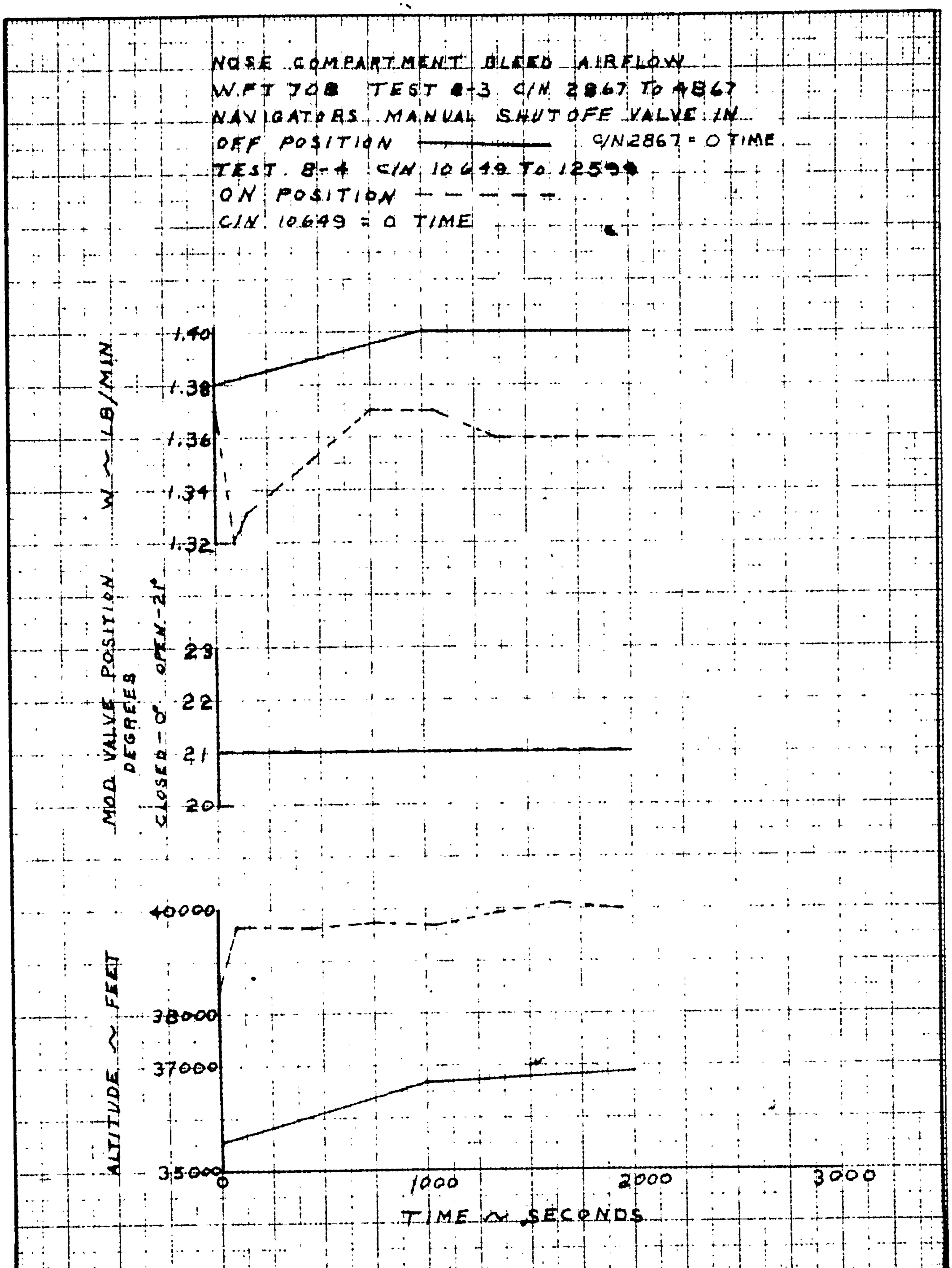


CALC	[signature]	10-22-55	REVISED	DATE	DEFROST SYSTEM VENTURI AND BLEED AIR FLOW WFT 709 - TEST 9-2	FIGURE 31
CHECK						RB-47B
APR						D-11,018
APR					BOEING AIRPLANE COMPANY WICHITA 1, KANSAS	PAGE 81 OF
CONTRACT NO.						



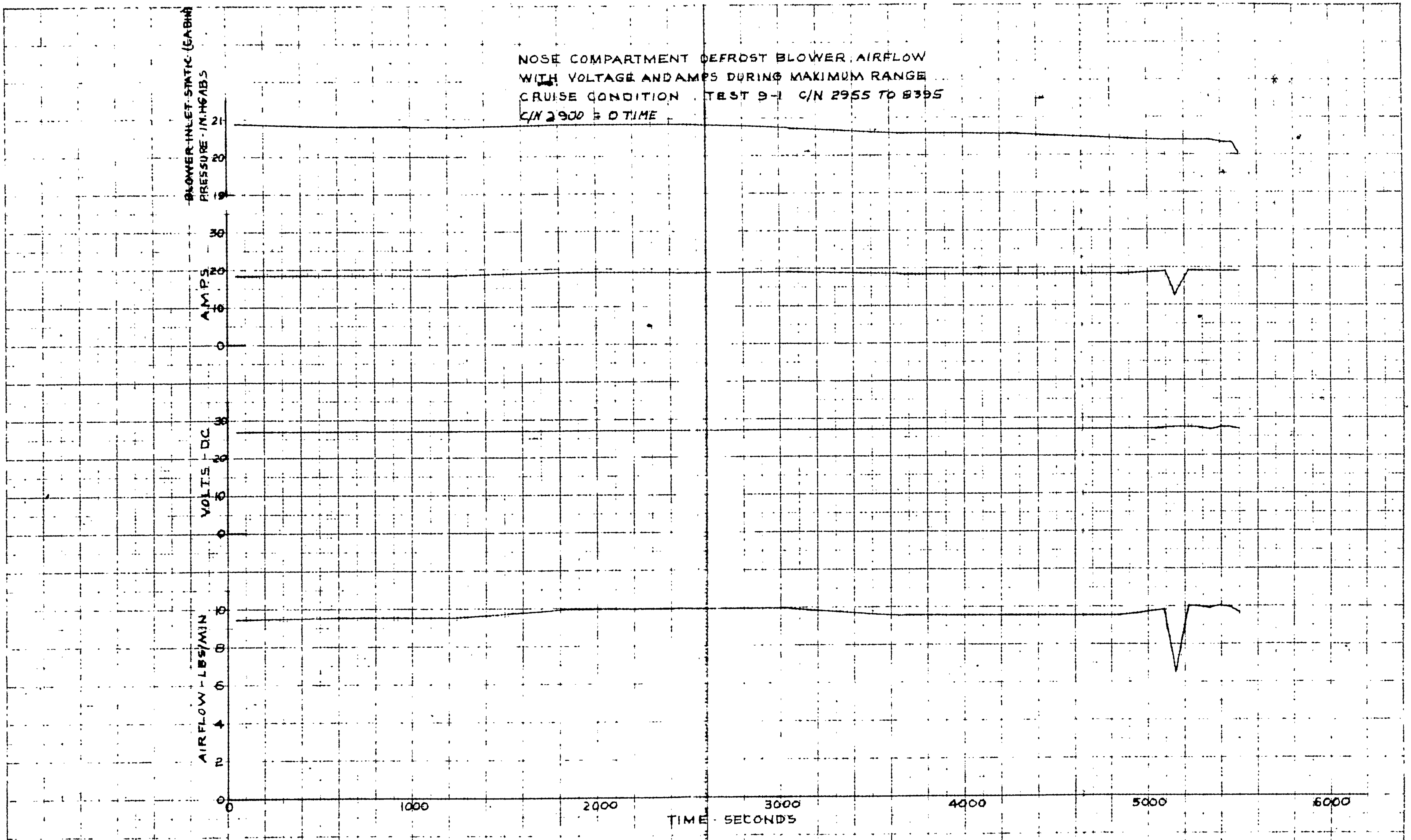
CALC	[signature]	10-22-53	REVISED	DATE	DEFROST SYSTEM VENTURI & BLEED AIRFLOW WFT-709 TEST 9-4	FIGURE 32
CHECK						RB-47E
APR					BOEING AIRPLANE COMPANY WICHITA 1, KANSAS	WD-14018
APR						PAGE 82 OF

CONTRACT NO.



CALC	M. PECHT	10-55	REVISED	DATE	DEFROST SYSTEM BLEED AIRFLOW WFT 708 TEST 8-3 & 8-4	Fig. 32A
CHECK	JBK	10-22-55				RB-47E WD-14018
APR					BOEING AIRPLANE COMPANY WICHITA 1, KANSAS	
APR						PAGE 83 OF

CONTRACT NO.



CALC		10-22-55	REVISED	DATE	DEFROST BLOWER AIRFLOW DURING MAXIMUM RANGE CRUISE - TEST 9-1	FIGURE 33
CHECK						RB-47E
APR						MD-11,018
APR					BOEING AIRPLANE COMPANY WICHITA 1, KANSAS	PAGE 84
						OF
CONTRACT NO.						

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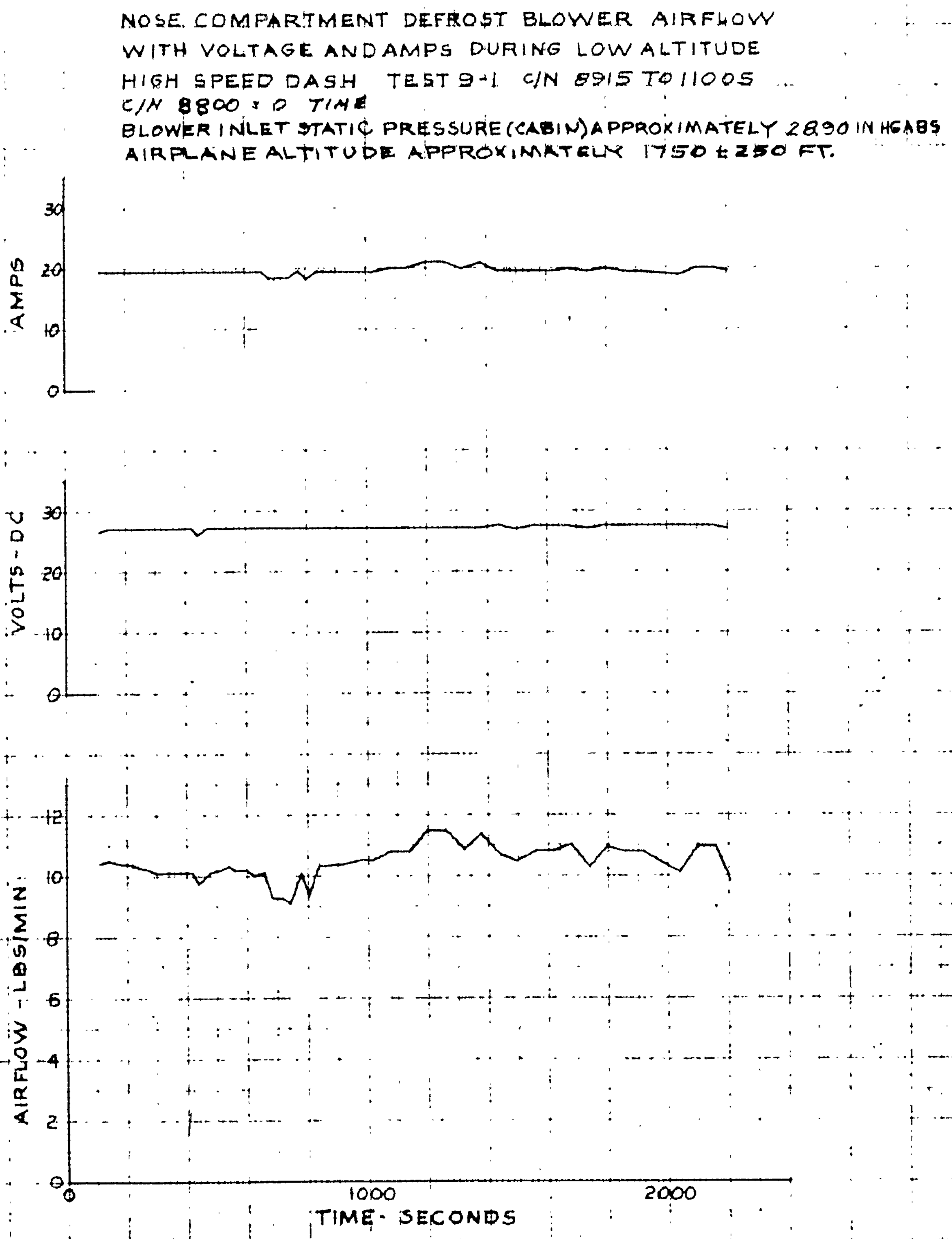
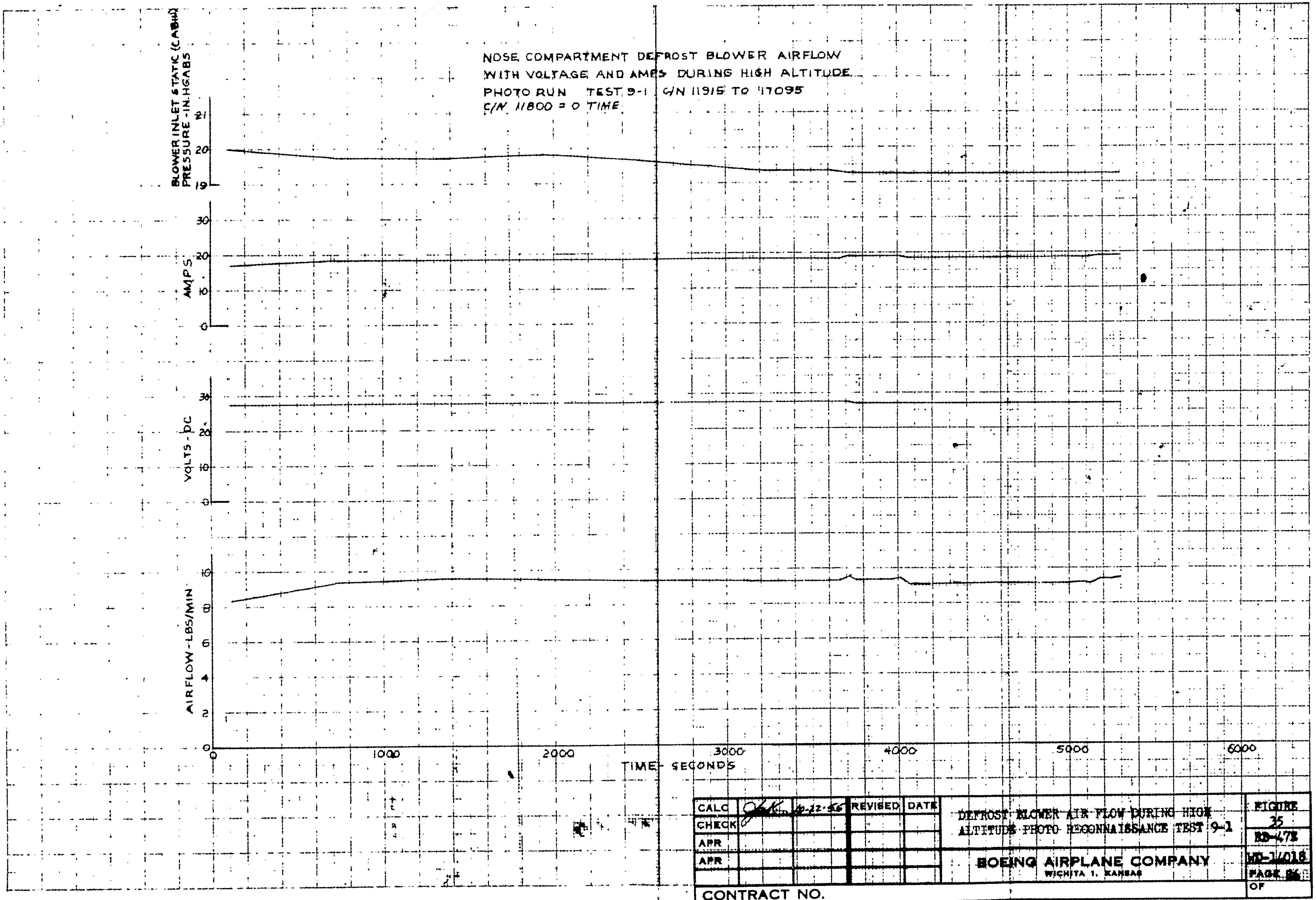


CALC	JBK	10-22-55	REVISED	DATE	DEFROST BLOWER AIRFLOW DURING LOW LEVEL PHOTO RECONNAISSANCE TEST 9-1	FIGURE 34
CHECK						RB-47E
APR					BOEING AIRPLANE COMPANY WICHITA 1, KANSAS	WD-14018
APR						PAGE 35 OF

CONTRACT NO.


NOSE COMPARTMENT DEFROST BLOWER AIRFLOW
WITH VOLTAGE AND AMPS DURING HIGH ALTITUDE
PHOTO RUN TEST 9-1 C/N 11915 TO 17095
C/N 11800 = 0 TIME
BLOWER INLET STATIC (CABIN) PRESSURE - IN. HG ABS
19
20
21
AMPS
0
10
20
30
VOLTS - DC
0
10
20
30
AIRFLOW - LBS/MIN
0
2
4
6
8
10
TIME - SECONDS
1000
2000
3000
4000
5000
6000
CALC
CHECK
APR
APR
REVISED
DATE
CONTRACT NO.
DEFROST BLOWER AIR FLOW DURING HIGH ALTITUDE PHOTO RECONNAISSANCE TEST 9-1
BOEING AIRPLANE COMPANY
WICHITA 1, KANSAS
FIGURE 35
RB-47E
WD-14018
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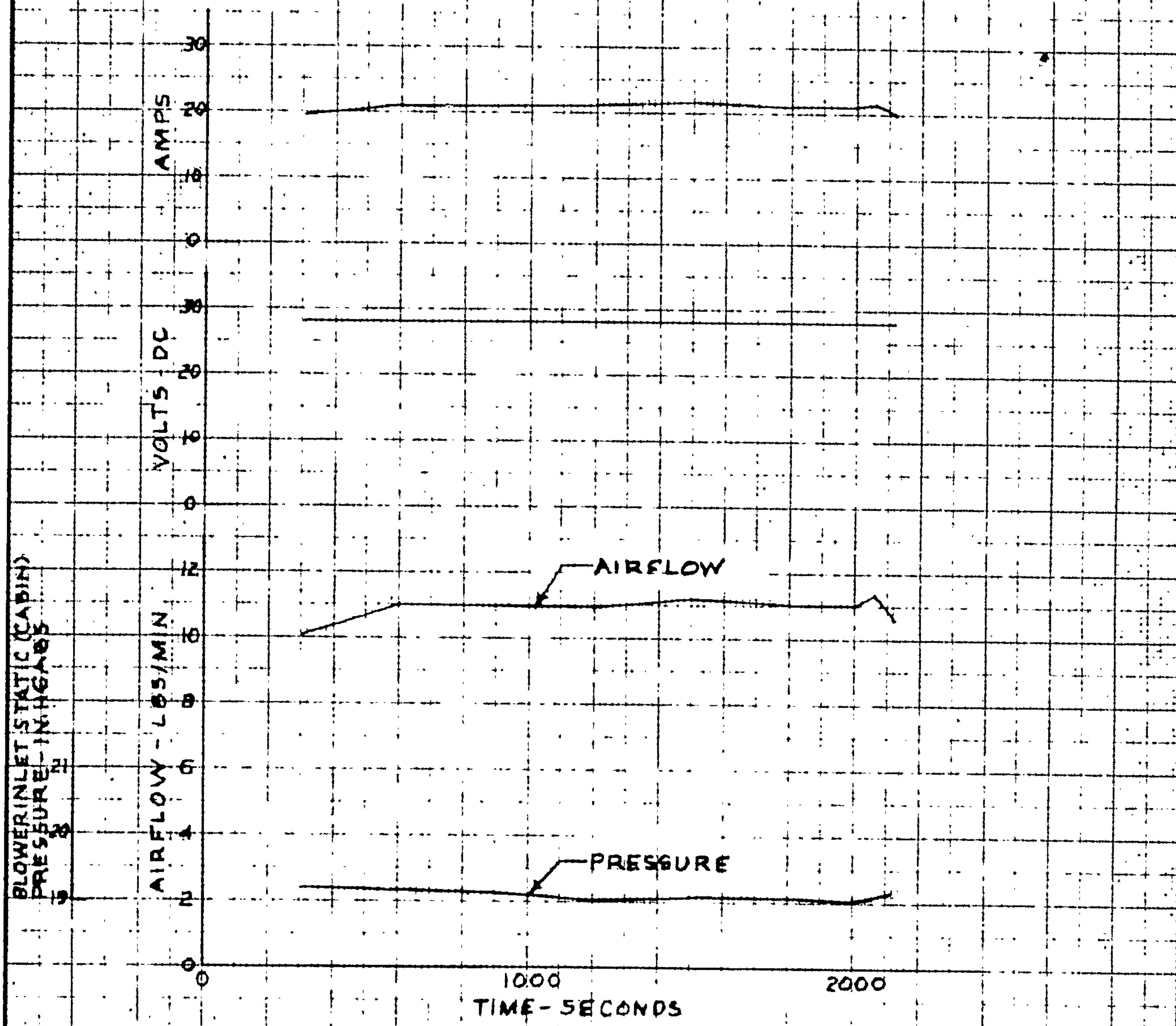
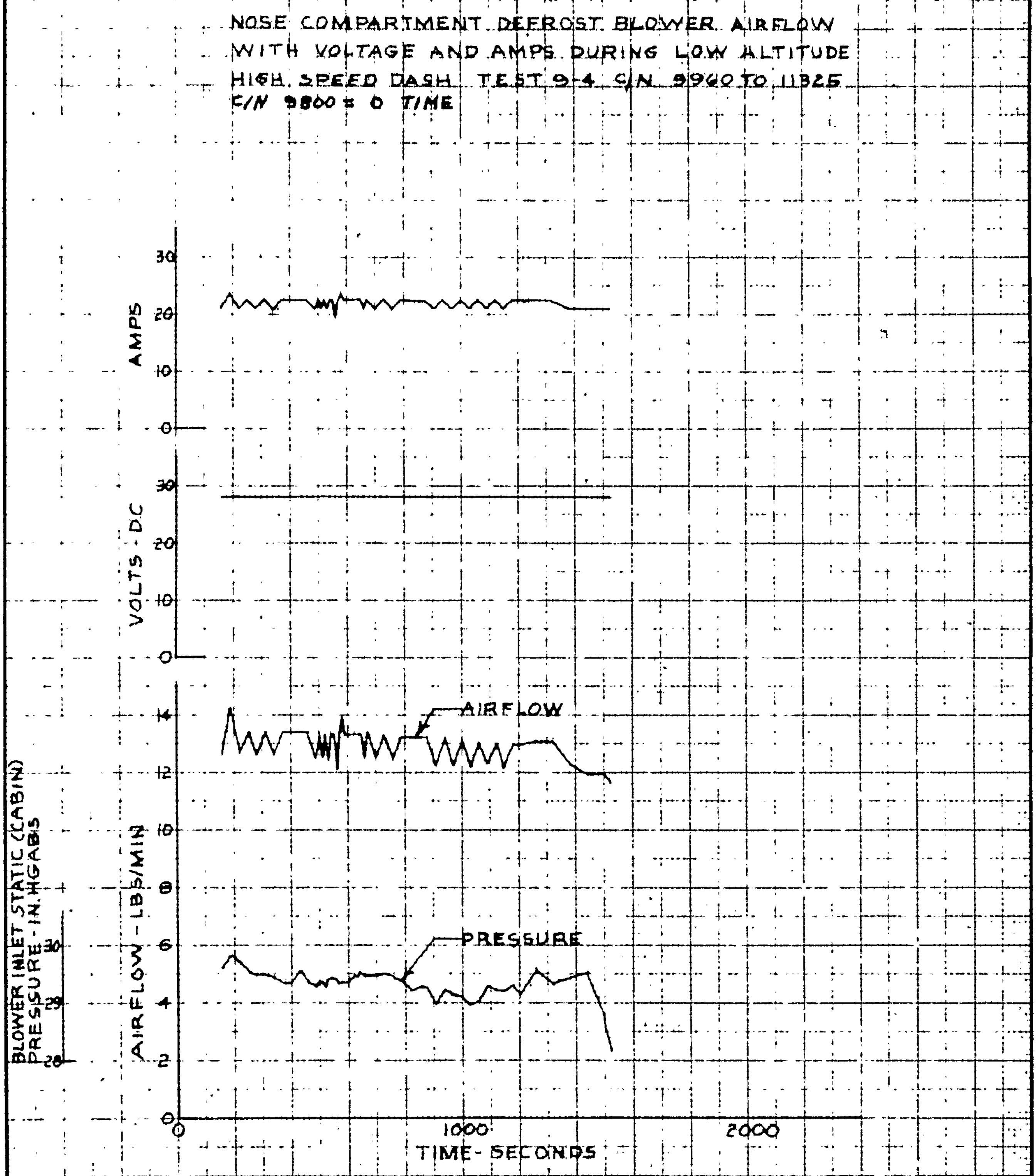
OF

NOSE COMPARTMENT DEFROST BLOWER AIRFLOW WITH VOLTAGE AND AMPS DURING HIGH ALTITUDE PHOTO RUN TEST 9-2 C/N 15309 TO 17120
C/N 15000 = 0 TIME

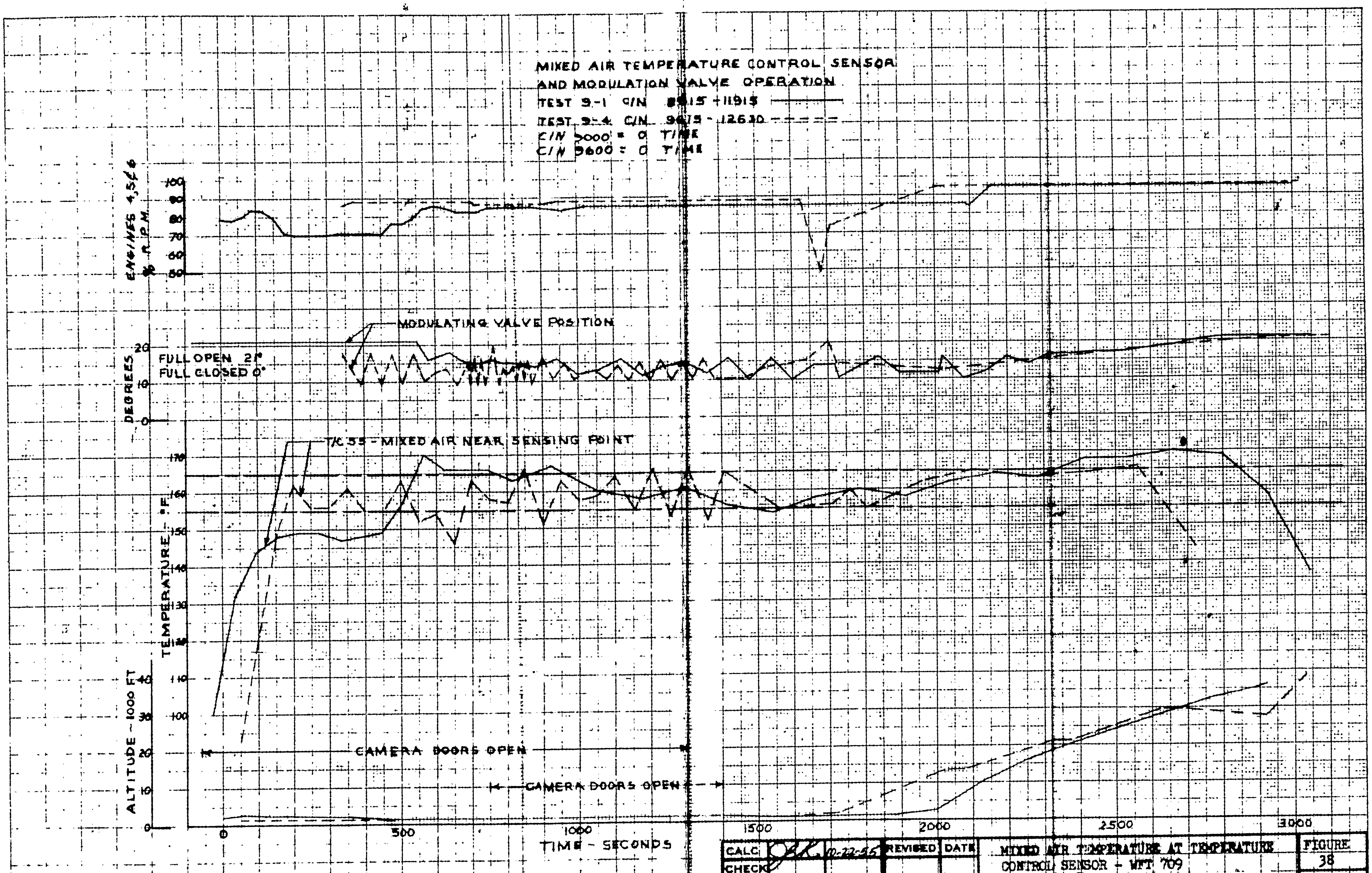


CALC	JBK	10-22-55	REVISED	DATE	DEFROST BLOWER AIRFLOW DURING HIGH ALTITUDE PHOTO RECONNAISSANCE - TEST9-2	FIGURE 36
CHECK						RB-47E
APR					BOEING AIRPLANE COMPANY WICHITA 1, KANSAS	WD-14018
APR						PAGE 87
CONTRACT NO.						OF



CALC	JBK	10-22-55	REVISED	DATE	DEFROST BLOWER AIRFLOW DURING LOW LEVEL PHOTO RECONNAISSANCE - TEST 9-4	FIGURE 37
CHECK						RB-47E
APR					BOEING AIRPLANE COMPANY WICHITA 1, KANSAS	WD-14018
APR						PAGE 88 OF

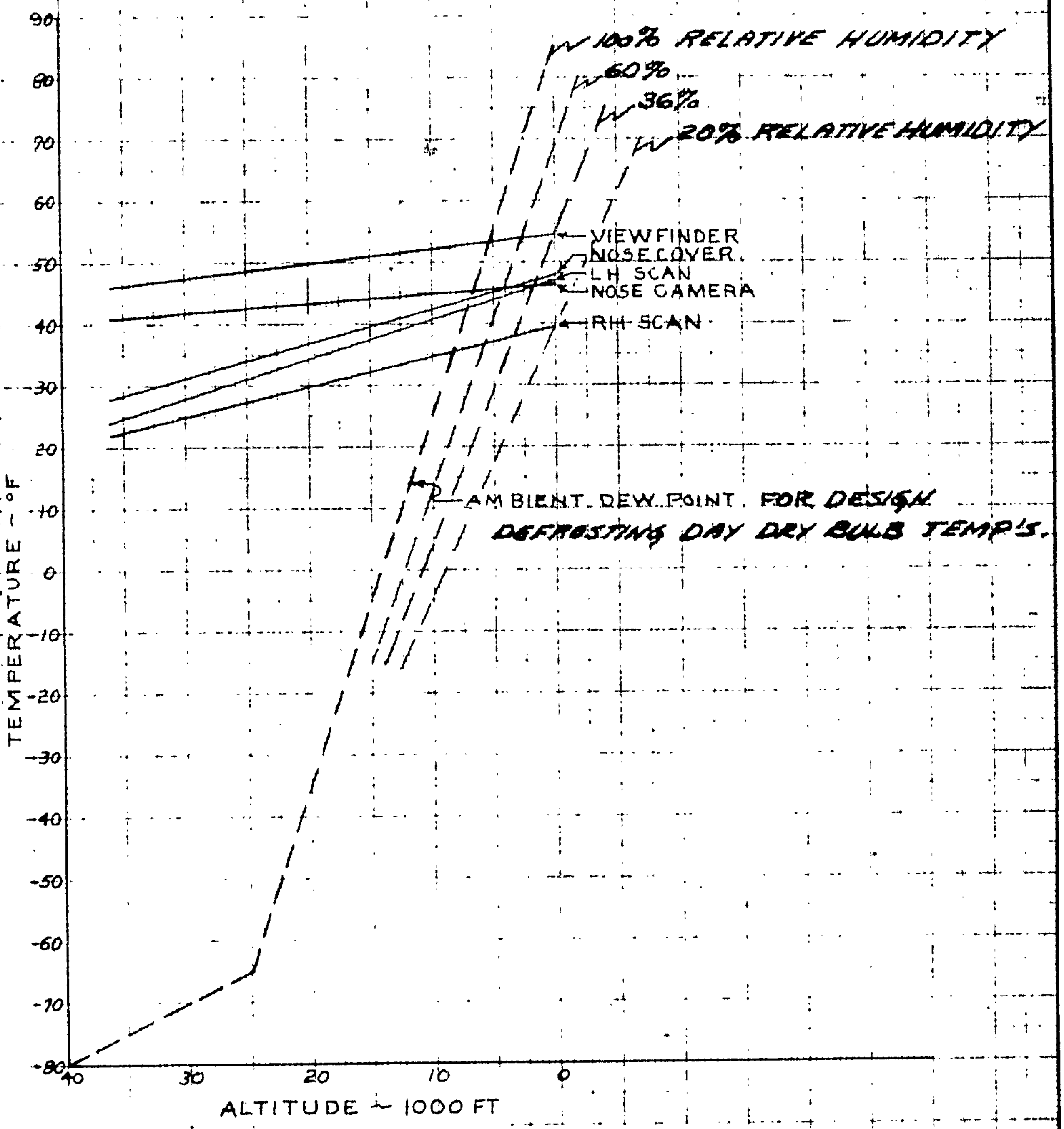
CONTRACT NO.



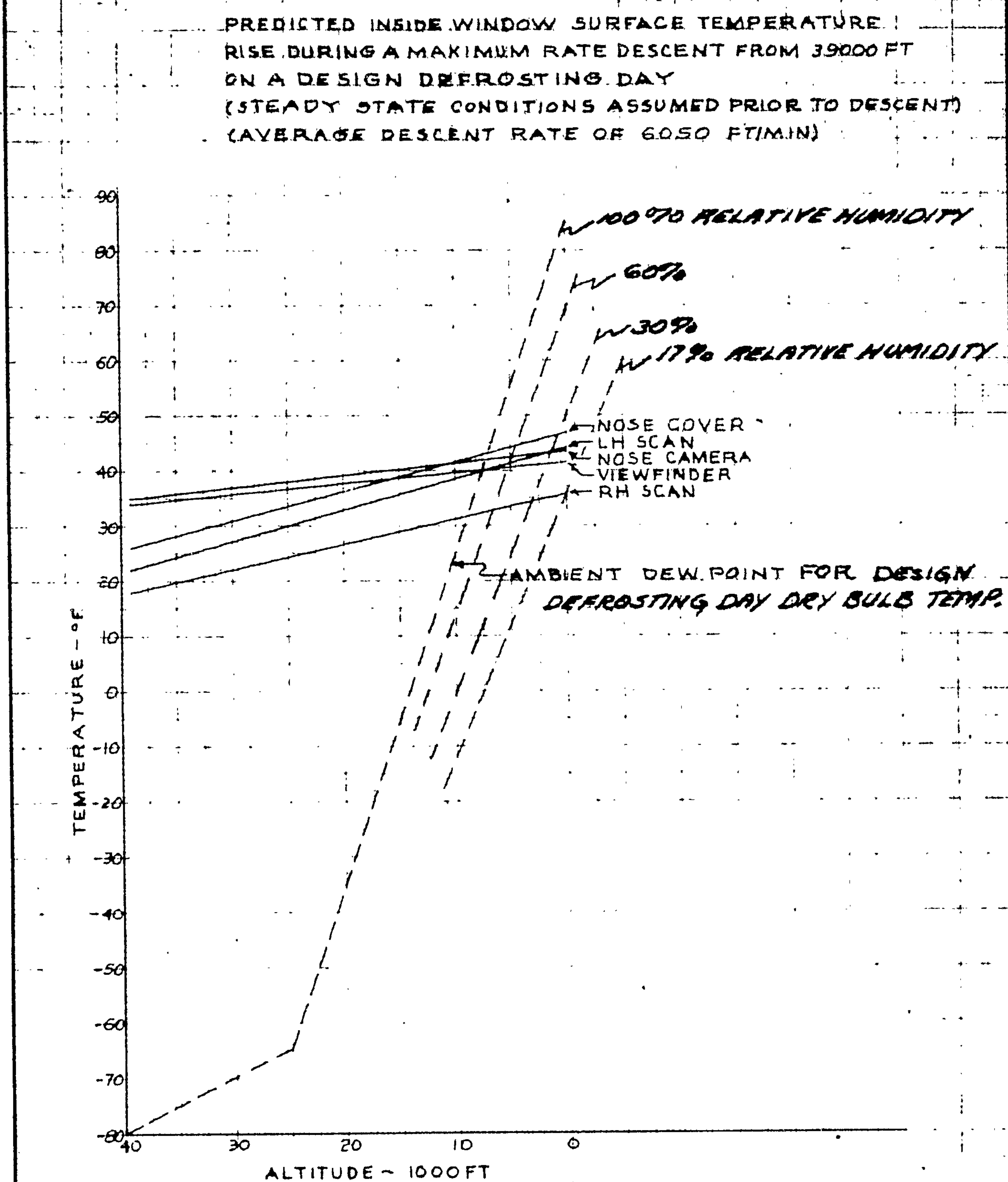
CALC	JRK	10-22-56	REVISED	DATE	MIXED AIR TEMPERATURE AT TEMPERATURE CONTROL SENSOR - WFT 709	FIGURE 38
CHECK						RB-47E
APR					BOEING AIRPLANE COMPANY WICHITA 1, KANSAS	WD-1/01E
APR						PAGE 89 OF

CONTRACT NO.

PREDICTED INSIDE WINDOW SURFACE TEMPERATURE
RISE DURING A MAXIMUM RATE DESCENT FROM 36,000 FT
ON A DESIGN, DEFROSTING DAY
(STEADY STATE CONDITIONS ASSUMED PRIOR TO DESCENT)
(AVERAGE DESCENT RATE OF 6050 FT/MIN)



CALC	JBK	10-22-55	REVISED	DATE	PREDICTED INSIDE WINDOW SURFACE TEMPERATURE RISE DURING A MAXIMUM RATE DESCENT FROM 36,000 FEET	FIGURE 39
CHECK			WAM	4/6/56		RB-47E
APR					BOEING AIRPLANE COMPANY	WD-14018
APR					WICHITA 1, KANSAS	PAGE 90
CONTRACT NO.						OF



CALC	OBK	10-22-55	REVISED	DATE	PREDICTED INSIDE WINDOW SURFACE TEMPERATURE RISE DURING A MAXIMUM RATE DESCENT FROM 39,000 FEET
CHECK			WAM	4/6/56	
APR					BOEING AIRPLANE COMPANY
APR					WICHITA 1, KANSAS

FIGURE 40

RB-47E

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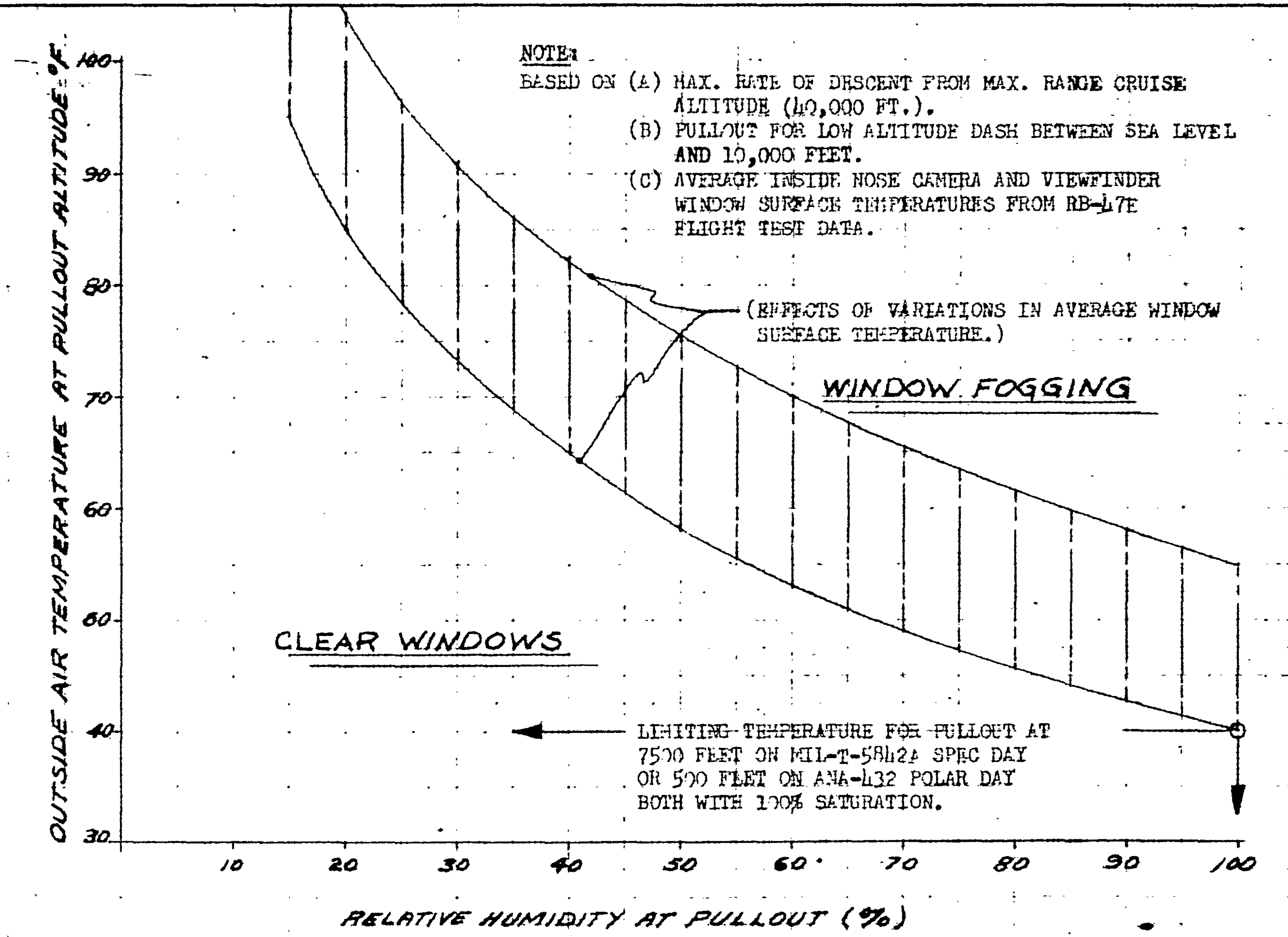
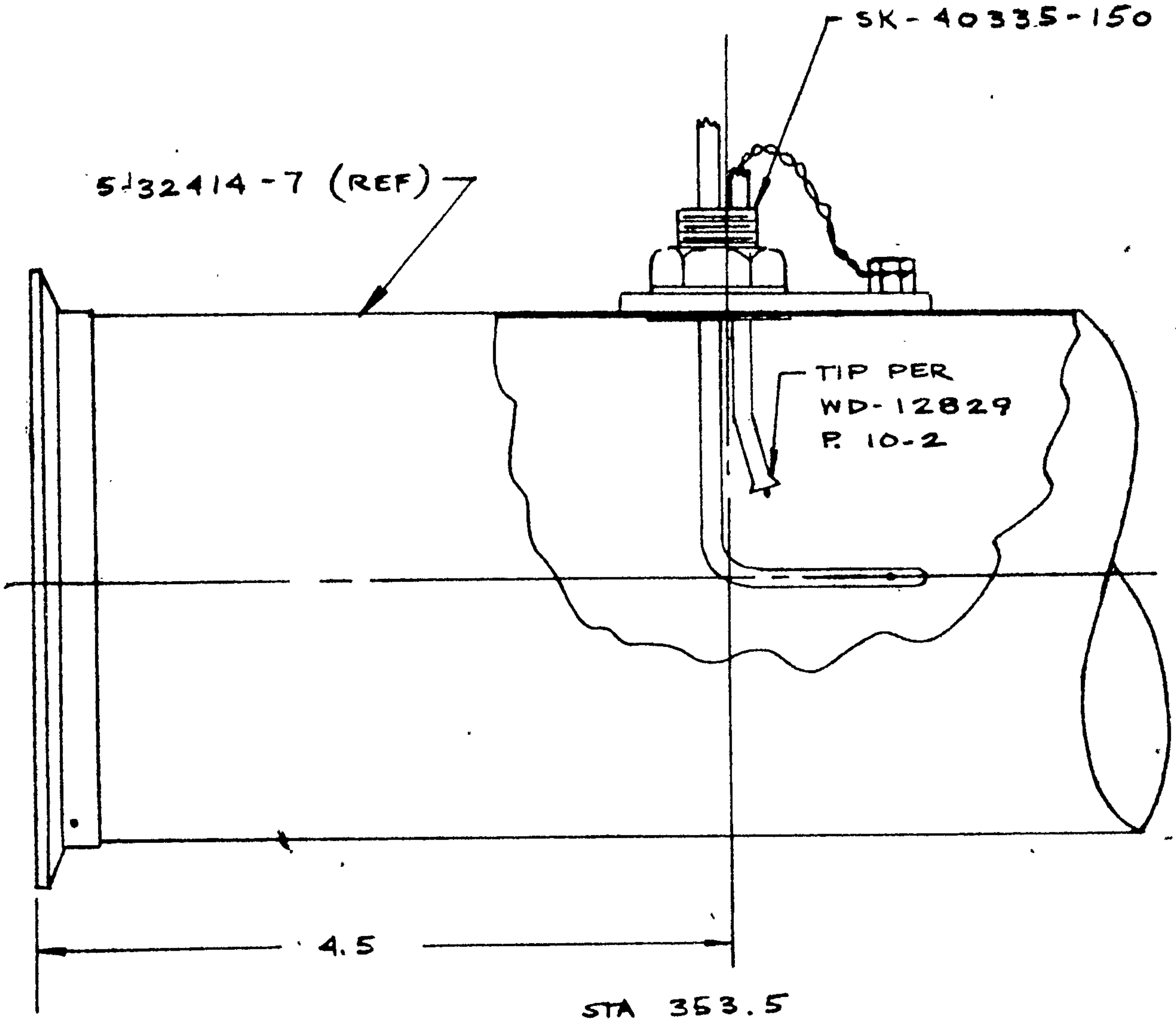
OF

CONTRACT NO.



CALC	WAM	4/6/56	REVISED	DATE	PREDICTION OF CONDITIONS FOR FOG FREE RB-47E NOSE CAMERA WINDOWS AT DESCENT PULLOUT	Fig. 40A
CHECK						RB-47E
APR					BOEING AIRPLANE COMPANY WICHITA 1, KANSAS	WD-14013
APR						PAGE 91a OF

CONTRACT NO.

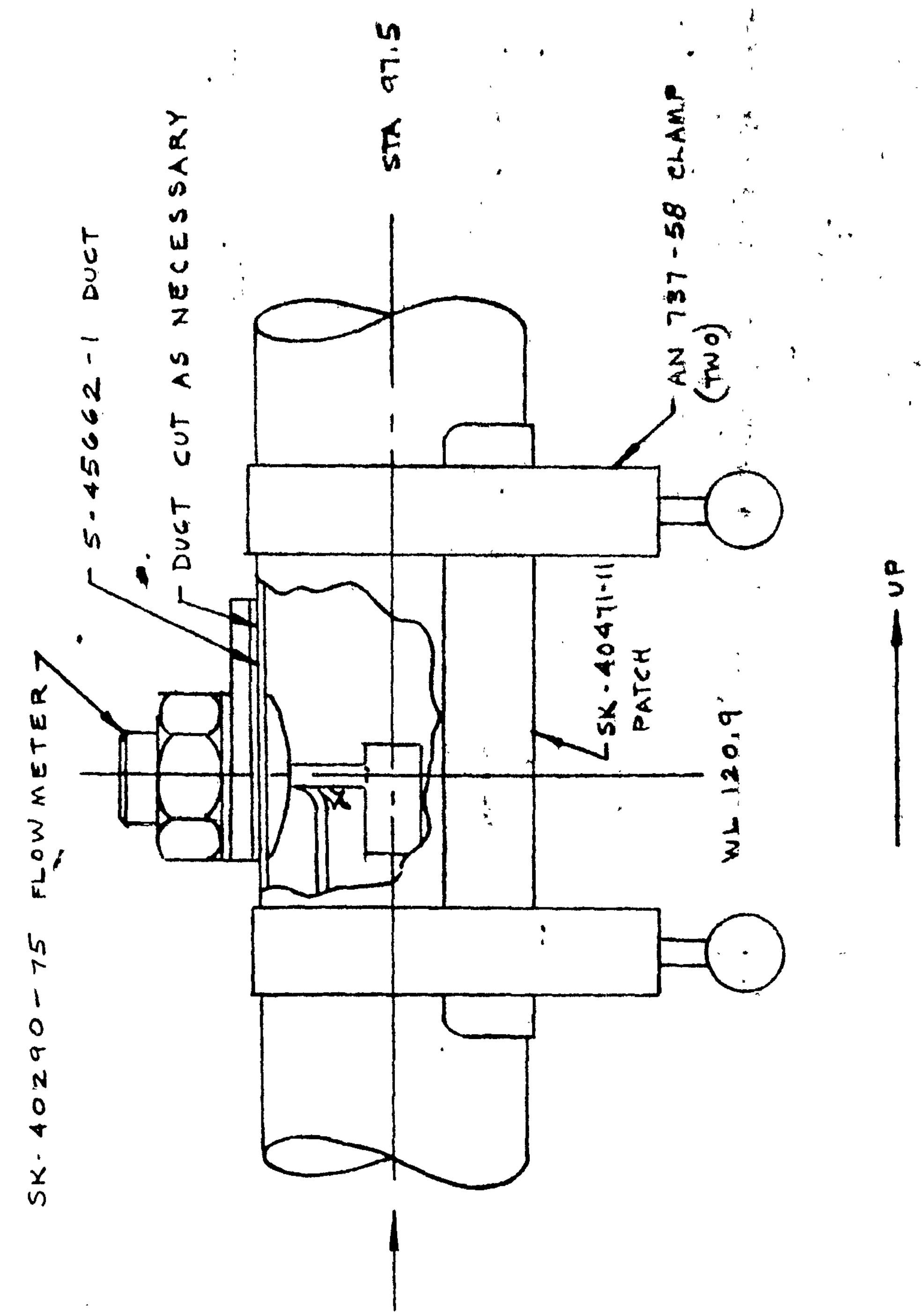


TC NO 46, STATIC NO 46
ENGINE BLEED AIR SUPPLY

REDRAWN FROM WD 13563, P. 4.4.46.

CALC		7-1-5	REVISED	DATE	FLIGHT TEST INSTRUMENTATION - ENGINE BLEED AIR SUPPLY STATION 353.5	FIGURE 41
CHECK	M PECHT	6-55				RB-47E
APR					BOEING AIRPLANE COMPANY	WD-14018
APR					WICHITA DIVISION WICHITA 1, KANSAS	PAGE 92
CONTRACT NO.						

FORM E-582



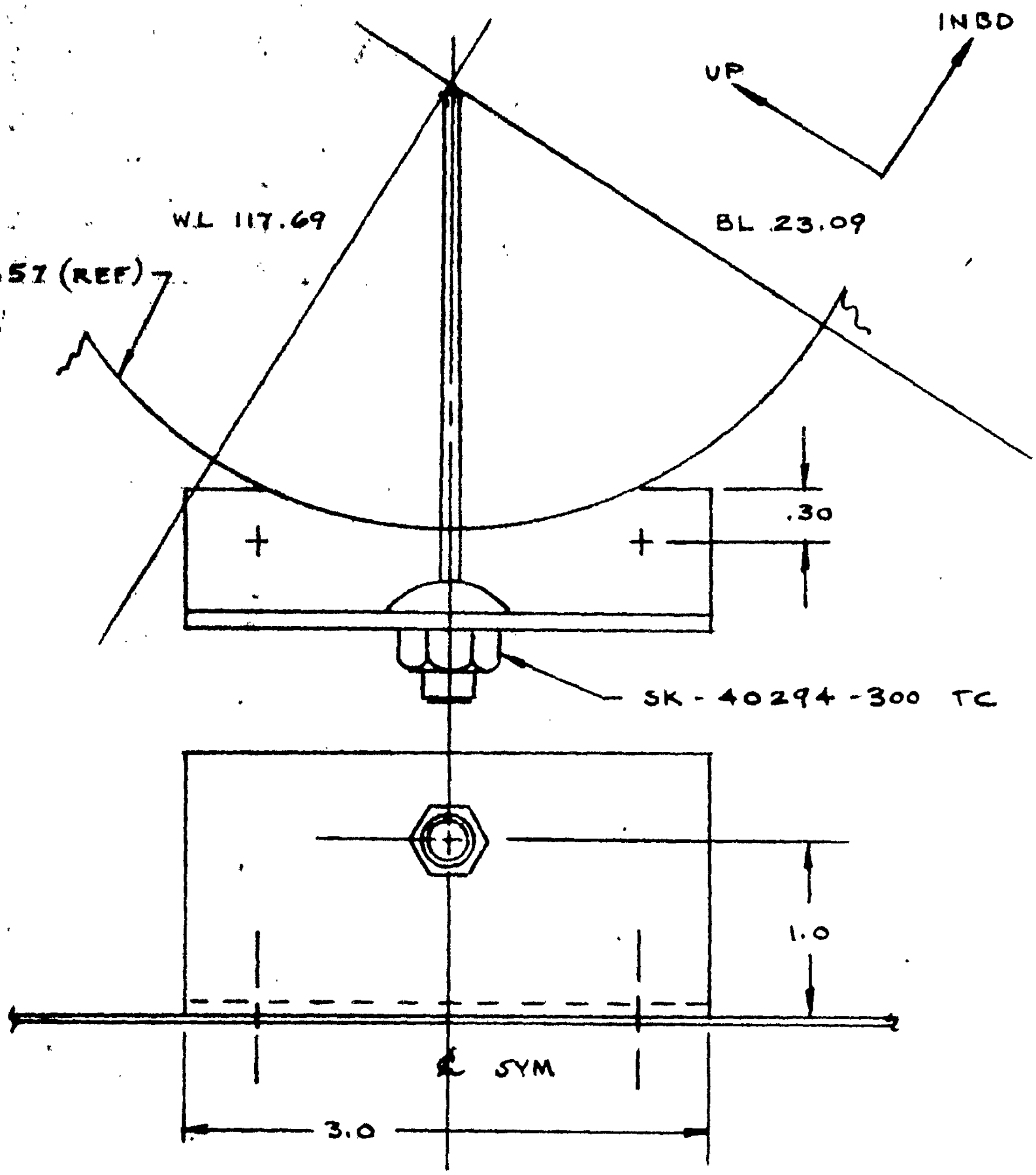
TC NO 47, STATIC NO. 47, TOTAL NO. 47

ENGINE BLEED AIR SUPPLY

REDRAWN FROM WD-13563, 4. 4. 47.

			REVISED	DATE		
CALC	[illegible]	7-1-[illegible]			FLIGHT TEST INSTRUMENTATION - ENGINE BLEED AIR SUPPLY STATION 97.5 W.L. 120.9	FIGURE 42
CHECK	M. PECHT	6-55			BOEING AIRPLANE COMPANY	RB-47E
APR					WICHITA DIVISION WICHITA 1, KANSAS	WD-14018
APR						PAGE 93
CONTRACT NO.						

FORM E-582



TC NO. 48

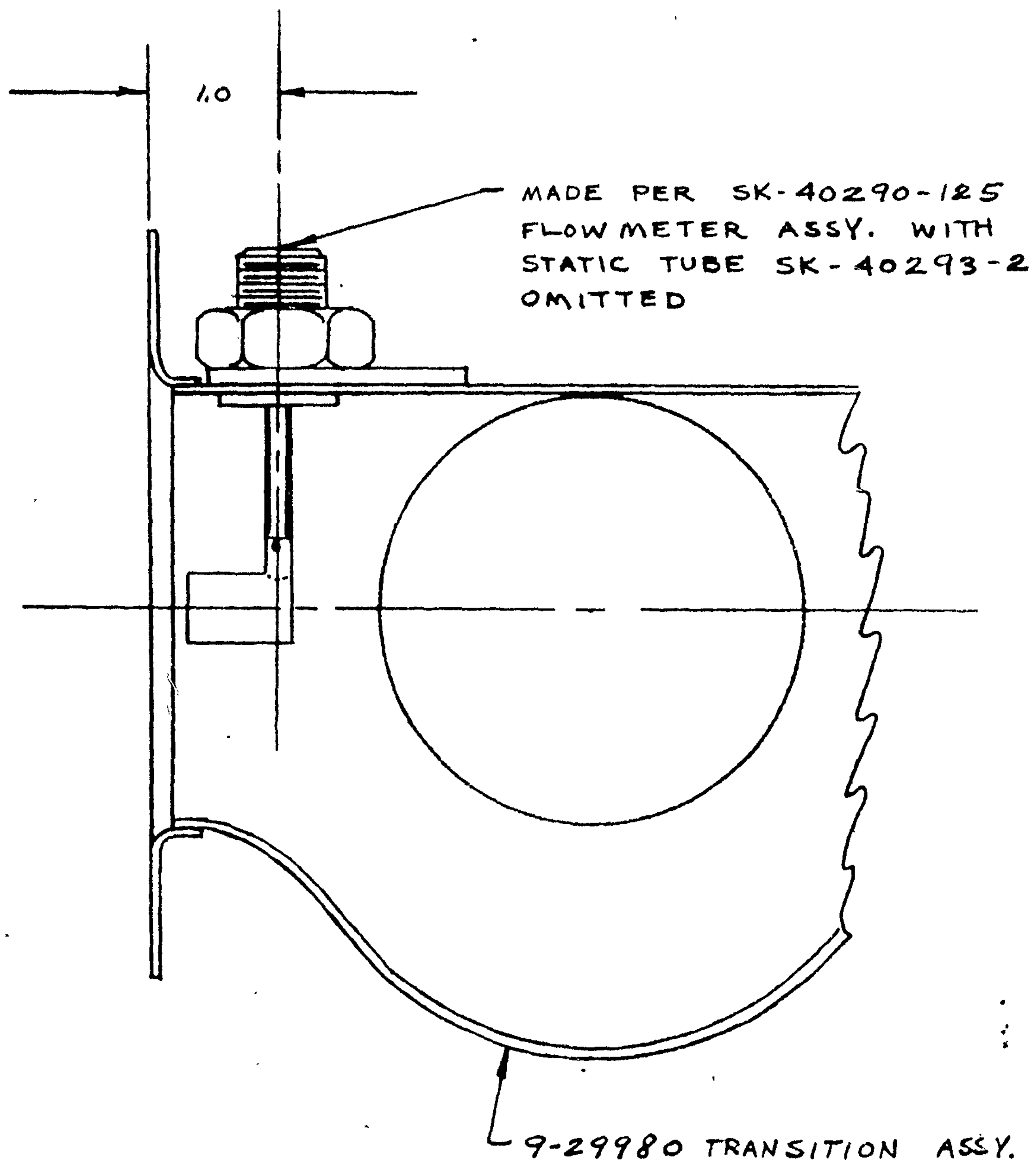
BLOWER INLET AIR

STA. 78.5, WL 117.1, RBL 23.1

REDRAWN FROM WD-13563 P. 4.4.48.

CALC	JML	7-1-	REVISED	DATE	FLIGHT TEST INSTRUMENTATION - BLOWER INLET AIR STATION 78.5 W.L. 117.1 RBL 23.1	FIGURE 43
CHECK	M. PECHT	6-65				RB-47E
APR					BOEING AIRPLANE COMPANY	WD-14018
APR					WICHITA DIVISION WICHITA 1, KANSAS	PAGE 94
CONTRACT NO.						

FORM E-582



T.C NO 51, PITOT NO. 51

BLOWER DISCHARGE AIR - UPSTREAM

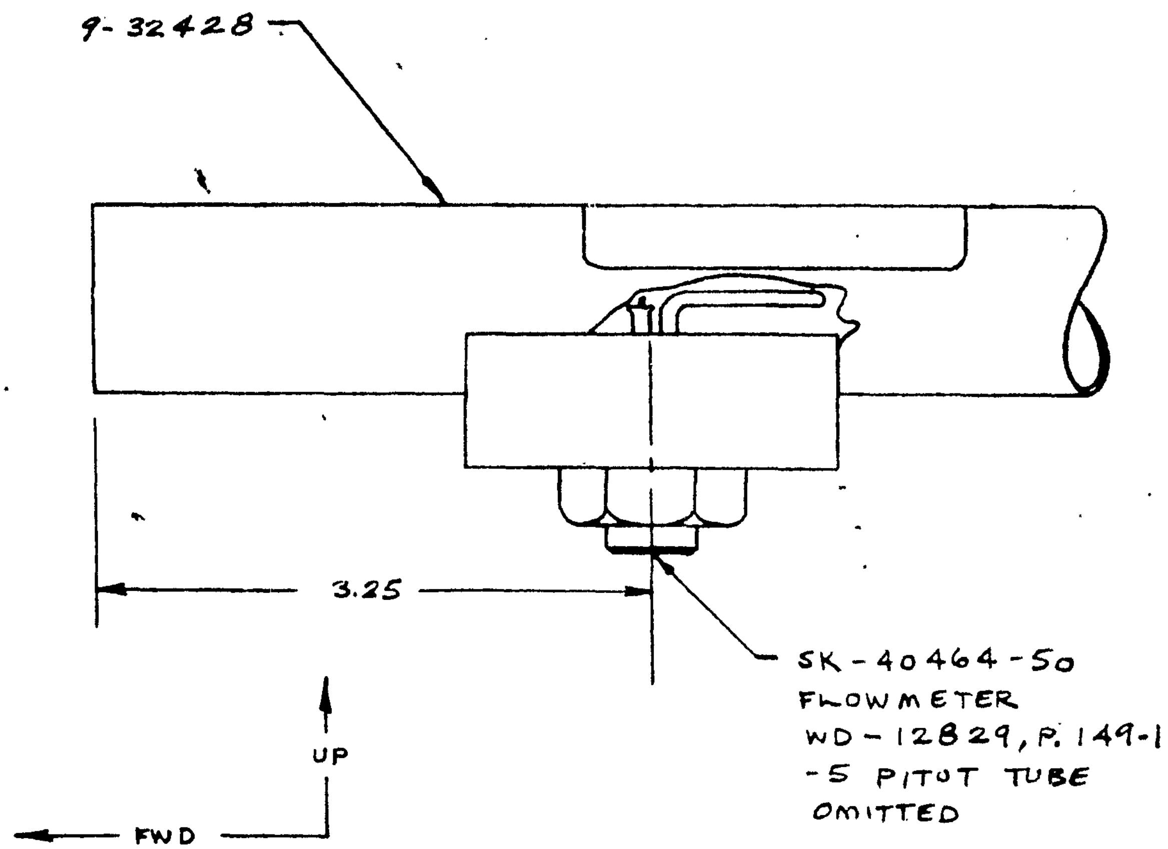
OF MIXING POINT.

REDRAWN FROM WD-13563 P. 4.4.51.

			REVISED	DATE		
CALC	[illegible]	7-6-4			FLIGHT TEST INSTRUMENTATION - BLOWER DISCHARGE AIR - UPSTREAM OF MIXING POINT	FIGURE 44
CHECK	M. PECHT	6-55				RB-47E
APR					BOEING AIRPLANE COMPANY	WD-14018
APR					WICHITA DIVISION WICHITA 1, KANSAS	PAGE 95

CONTRACT NO.

FORM E-582



TC NO 59 , STATIC NO 59

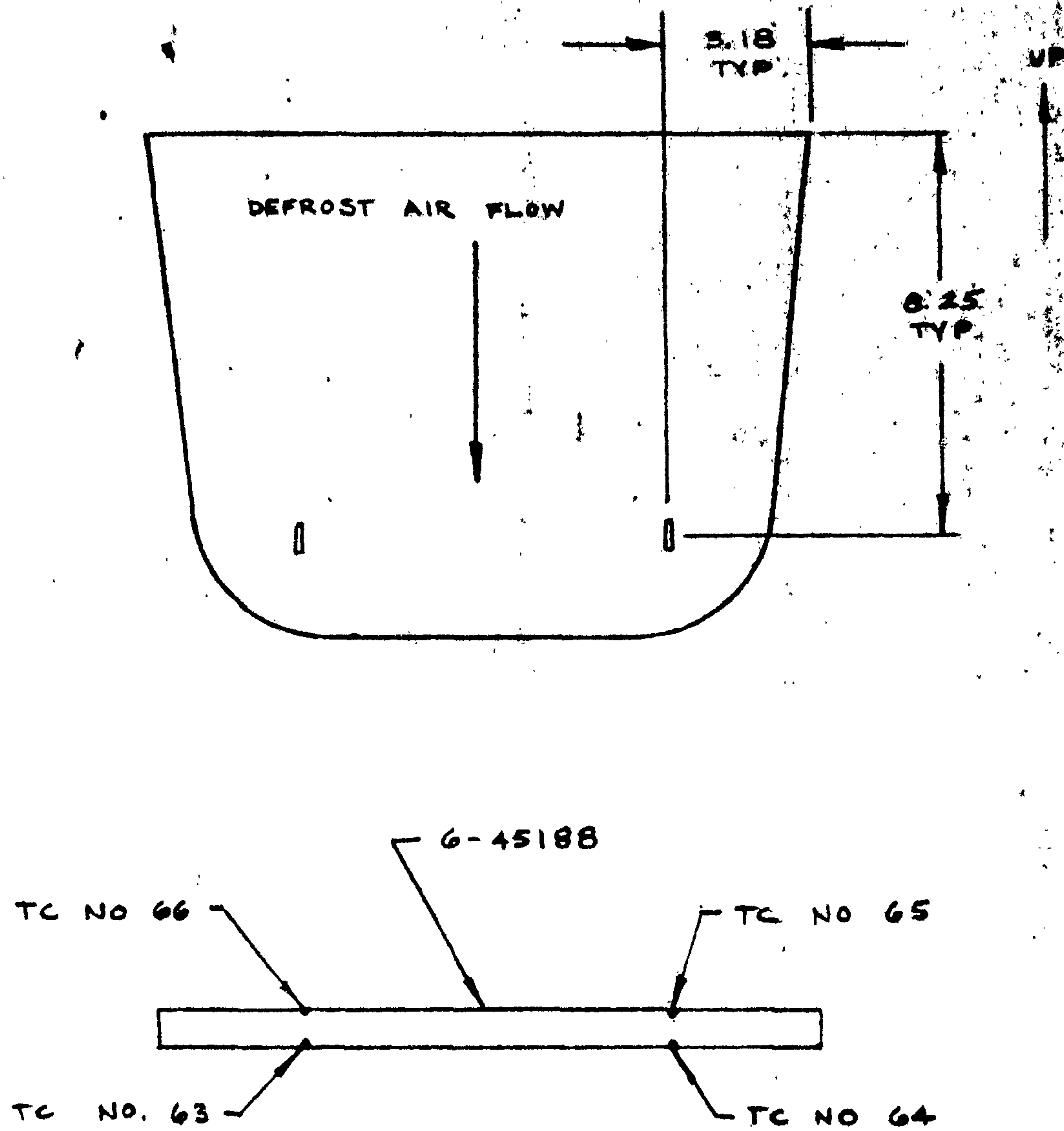
NOSE CAMERA WINDOW OUTSIDE SUPPLY DUCT, DOWNSTREAM OF CHECK VALVE.

REDRAWN FROM WD-13563, P. 4.4.59.

			REVISED	DATE		
CALC	[illegible]	7-6-[illegible]			FLIGHT TEST INSTRUMENTATION - NOSE CAMERA WINDOW OUTSIDE SUPPLY DUCT, DOWNSTREAM OF CHECK VALVE	FIGURE 45
CHECK	M. PECNT	6-55				RB-47E
APR					BOEING AIRPLANE COMPANY	WD-14018
APR					WICHITA DIVISION WICHITA 1. KANSAS	PAGE 96

CONTRACT NO.

FORM E-582

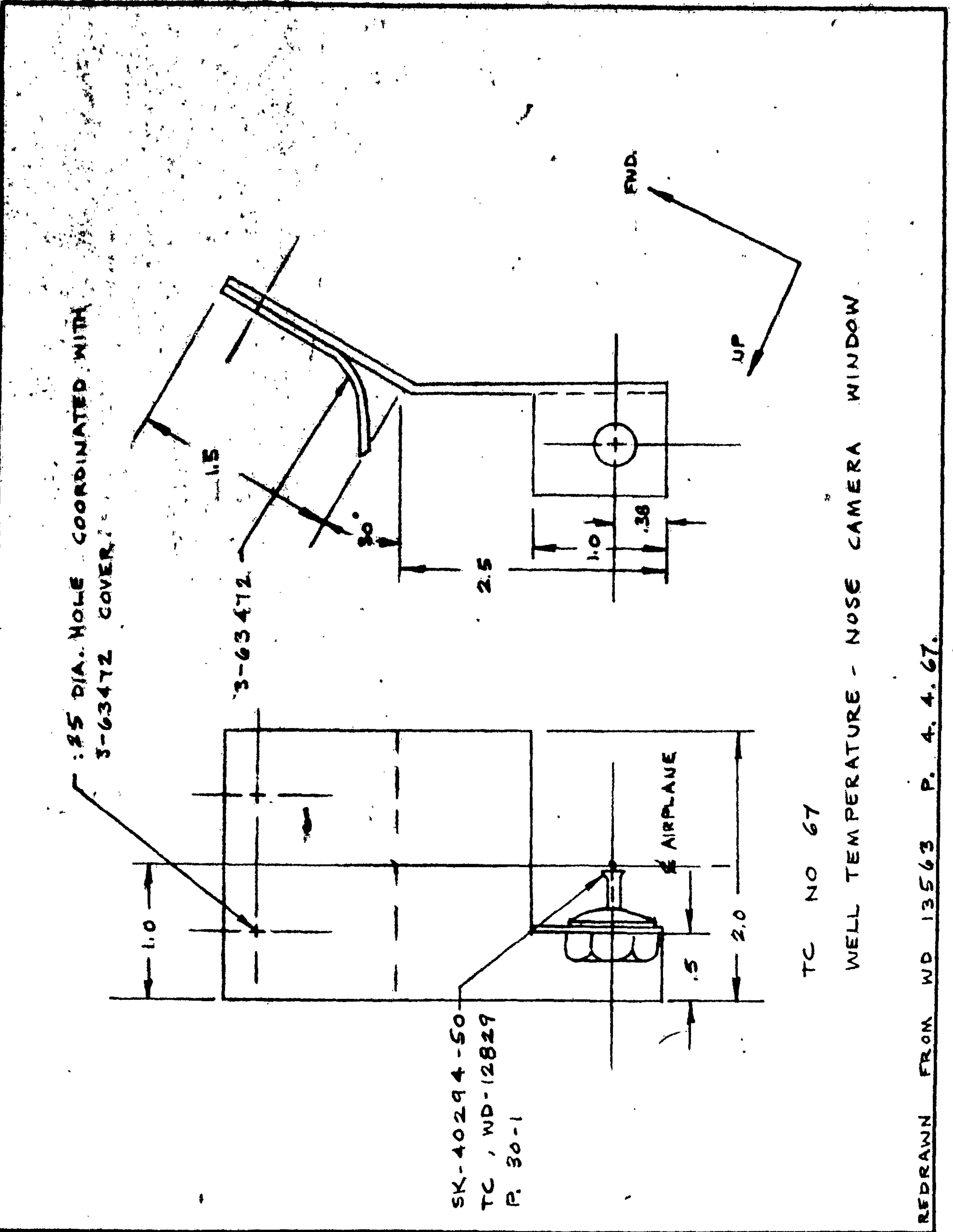


TC'S NO. 63, 64, 65, + 66
SURFACE TEMPERATURE, NOSE CAMERA WINDOW

REDRAWN FROM WD-13563, P. 4.4.63.

					FLIGHT TEST INSTRUMENTATION - SURFACE TEMPERATURE, NOSE CAMERA WINDOW	FIGURE 46
CALC	JM	7-6-4	REVISED	DATE		RB-47E
CHECK	M. PECHT	6-55			BOEING AIRPLANE COMPANY	WD-14018
APR					WICHITA DIVISION WICHITA 1, KANSAS	PAGE 97
APR						
CONTRACT NO.						

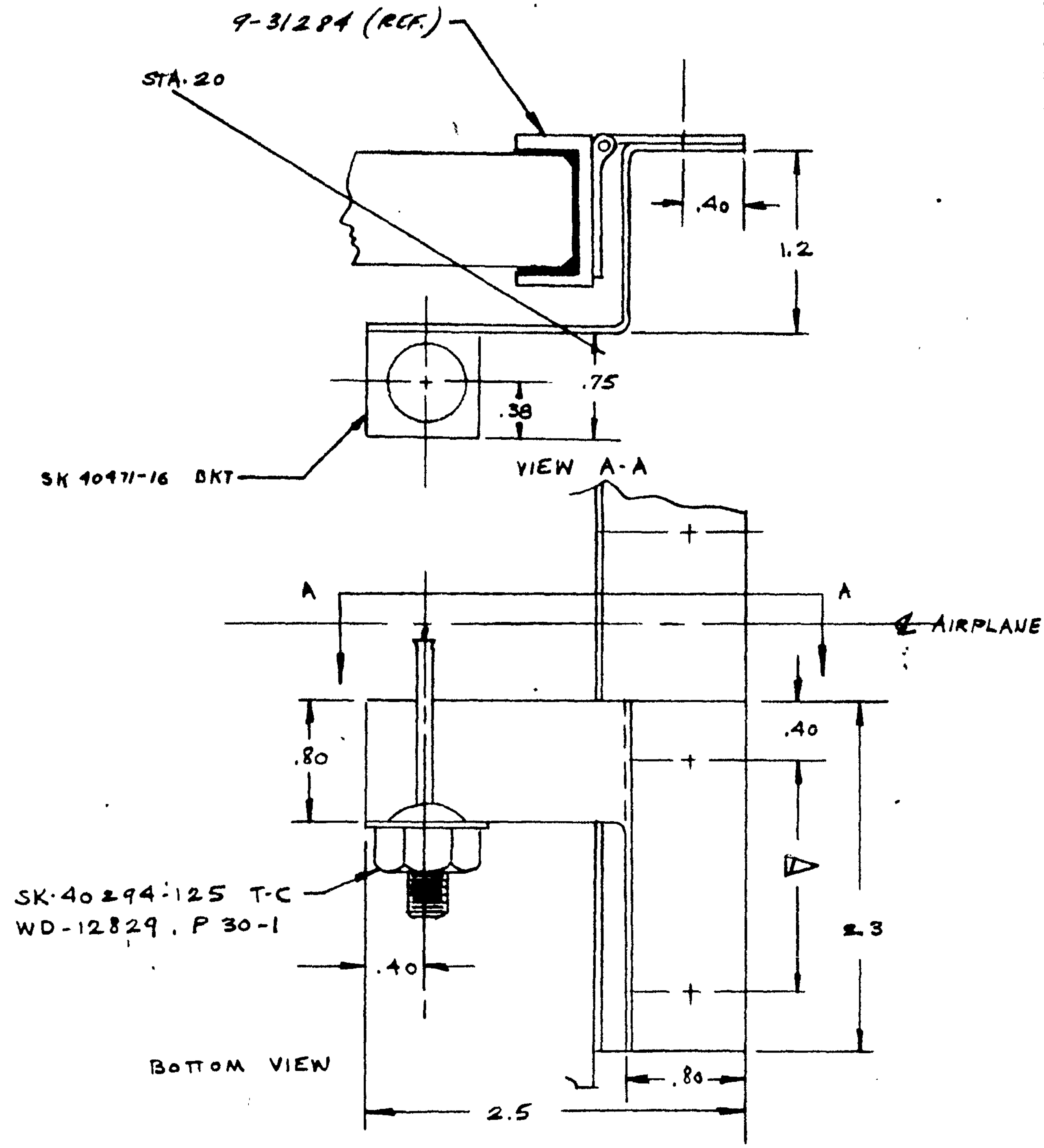
FORM E-582



CALC	[illegible]	[illegible]	REVISED	DATE	FLIGHT TEST INSTRUMENTATION - WELL TEMPERATURE, NOSE CAMERA WINDOW	FIGURE 47
CHKD	M. PECHT	6-55				RB-47E WD-14018
APR					BOEING AIRPLANE COMPANY	
APR					WICHITA DIVISION — WICHITA 1, KANSAS	PAGE 98
CONTRACT NO.						

FORM E-582

COORDINATE WITH 9-31284



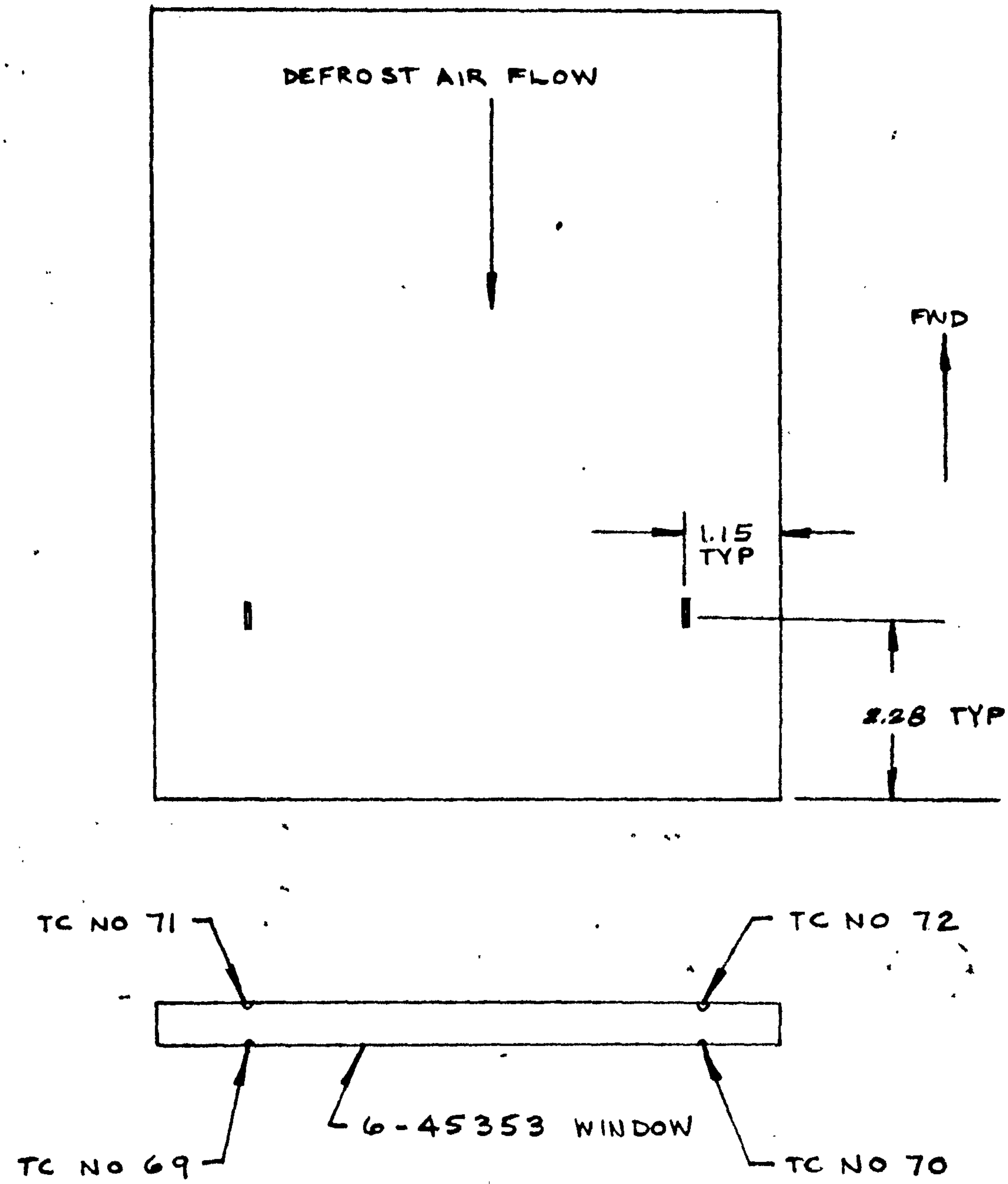
TC NO. 68

WELL TEMPERATURE - NOSE CAMERA WINDOW

REDRAWN FROM WD-13563, 4.4.68.

			REVISED	DATE		
CALC	[illegible]	7-6-4			FLIGHT TEST INSTRUMENTATION - WELL TEMPERATURE, NOSE CAMERA WINDOW	FIGURE 48
CHECK	M. PECNT	6-65				RB-47E
APR					BOEING AIRPLANE COMPANY	WD-14018
APR					WICHITA DIVISION — WICHITA 1, KANSAS	PAGE 99
CONTRACT NO.						

FORM E-582



TC'S NO 69, 70, 71, + 72

SURFACE TEMPERATURE - VIEWFINDER WINDOW

REDRAWN FROM WD-13563 P. 4.4.69.

CALC	JHC 7-7-4	REVISED	DATE
CHECK	M. PECHT 6-55		
APR			
APR			

FLIGHT TEST INSTRUMENTATION - SURFACE TEMPERATURE, VIEWFINDER WINDOW

BOEING AIRPLANE COMPANY

WICHITA DIVISION WICHITA 1, KANSAS

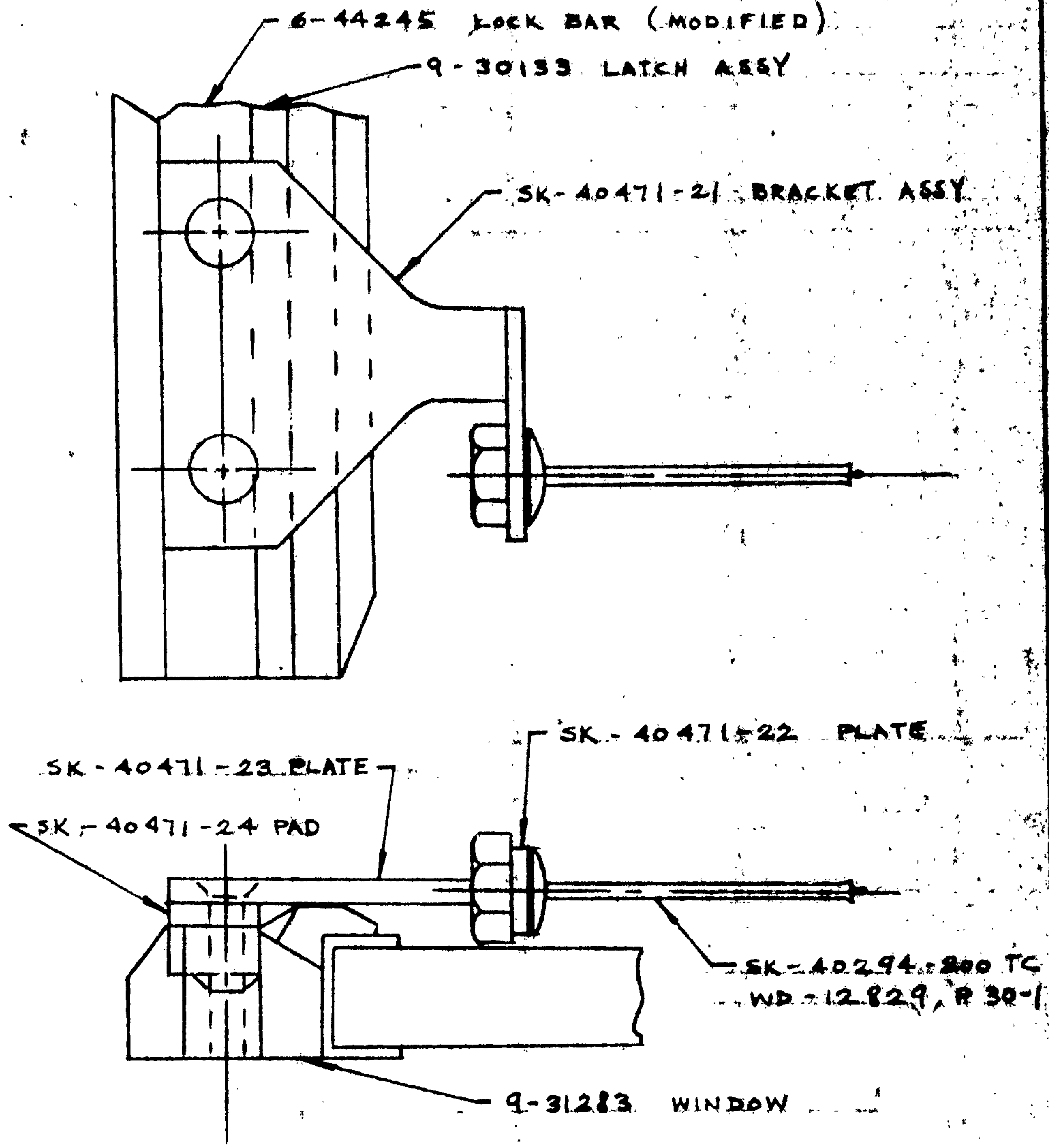
FIGURE 49

RB-47E

WD-14018

CONTRACT NO.

FORM E-582



TC NO 73

WELL TEMPERATURE - VIEWFINDER WINDOW

REDRAWN FROM WD-13563, P. 4.4.73.

CALC	JHW	7-7-4	REVISED	DATE	FLIGHT TEST INSTRUMENTATION - WELL TEMPERATURE, VIEWFINDER WINDOW
CHECK	M. PECHT	6-55			
APR.					BOEING AIRPLANE COMPANY
APR					WICHITA DIVISION — WICHITA 1., KANSAS

FIGURE 50

RB-47E

MD-14018

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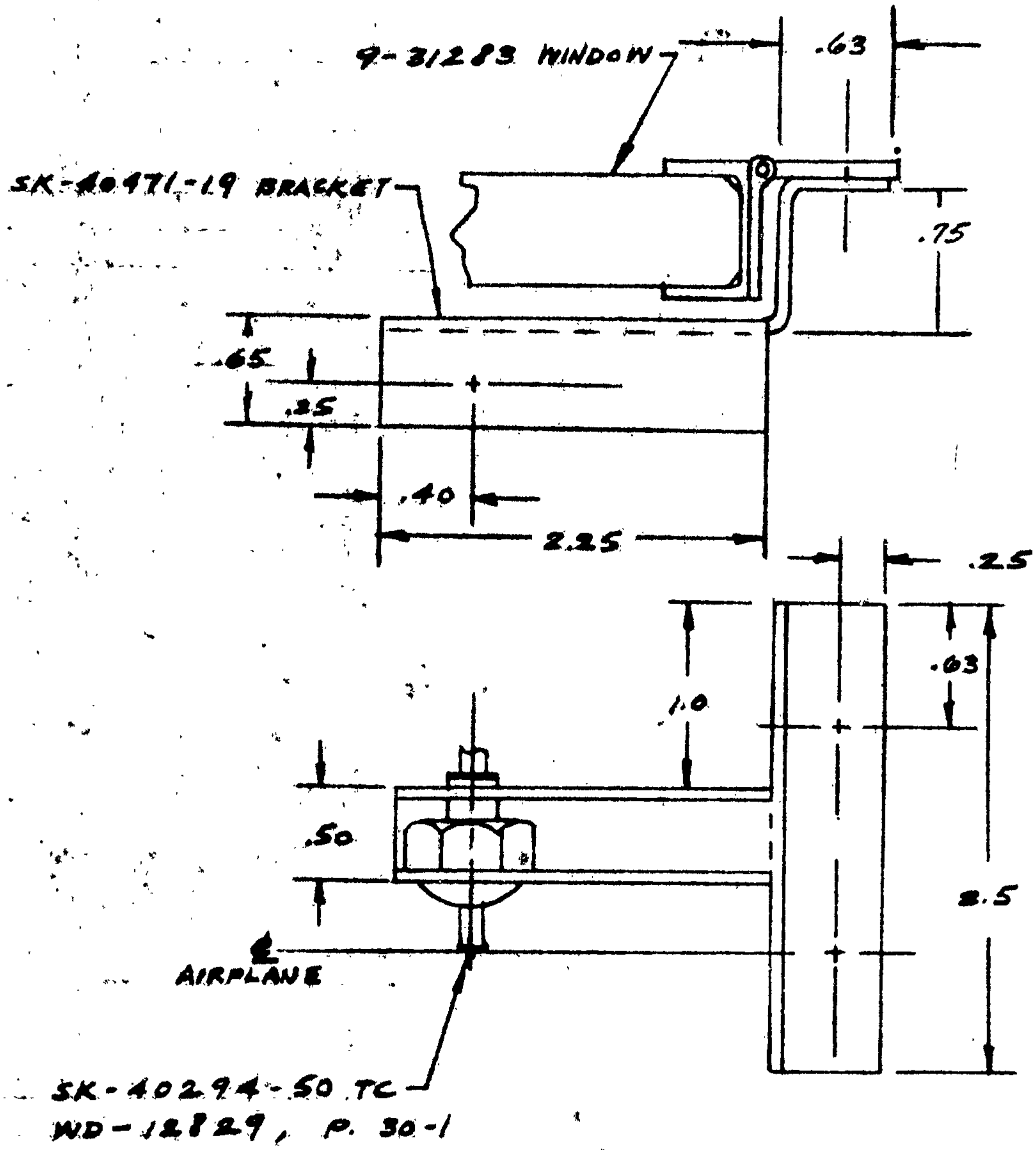
CONTRACT NO.

FORM E-582



TC NO. 74

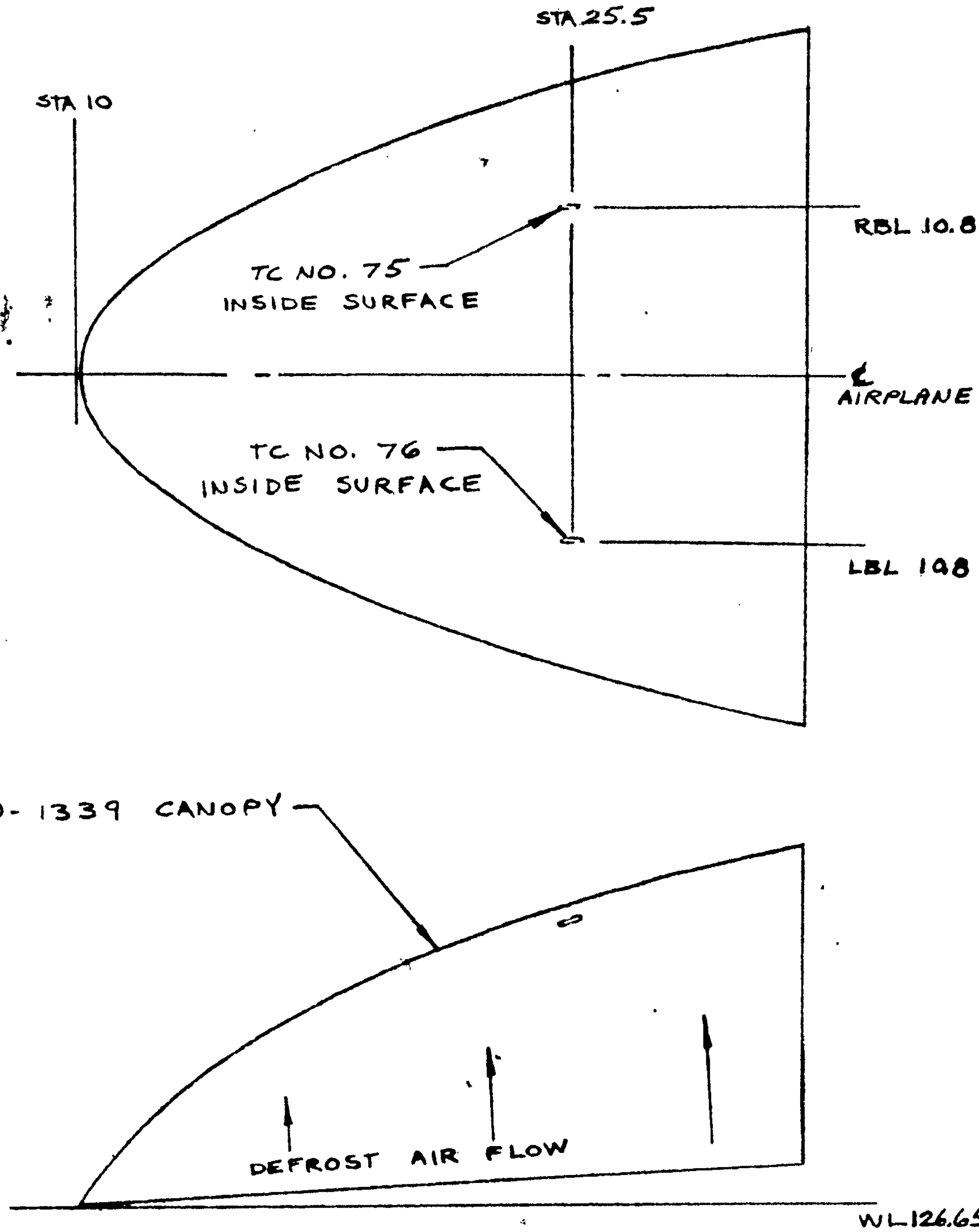
WELL TEMPERATURE - VIEWFINDER WINDOW

REDRAWN FROM WD 13563, P. 4.4.74.

			REVISED	DATE		
CALC	JML	7-7-4			FLIGHT TEST INSTRUMENTATION - WELL TEMPERATURE, VIEWFINDER WINDOW	FIGURE 51
CHECK	M. PECUT	6-56				RB-47E
APR					BOEING AIRPLANE COMPANY	WD-14018
APR					WICHITA DIVISION WICHITA, KANSAS	PAGE 102

CONTRACT NO.

FORM E-582



TC'S NO 75 + 76
INSIDE SURFACE TEMPERATURE,
NOSE COVER WINDOW

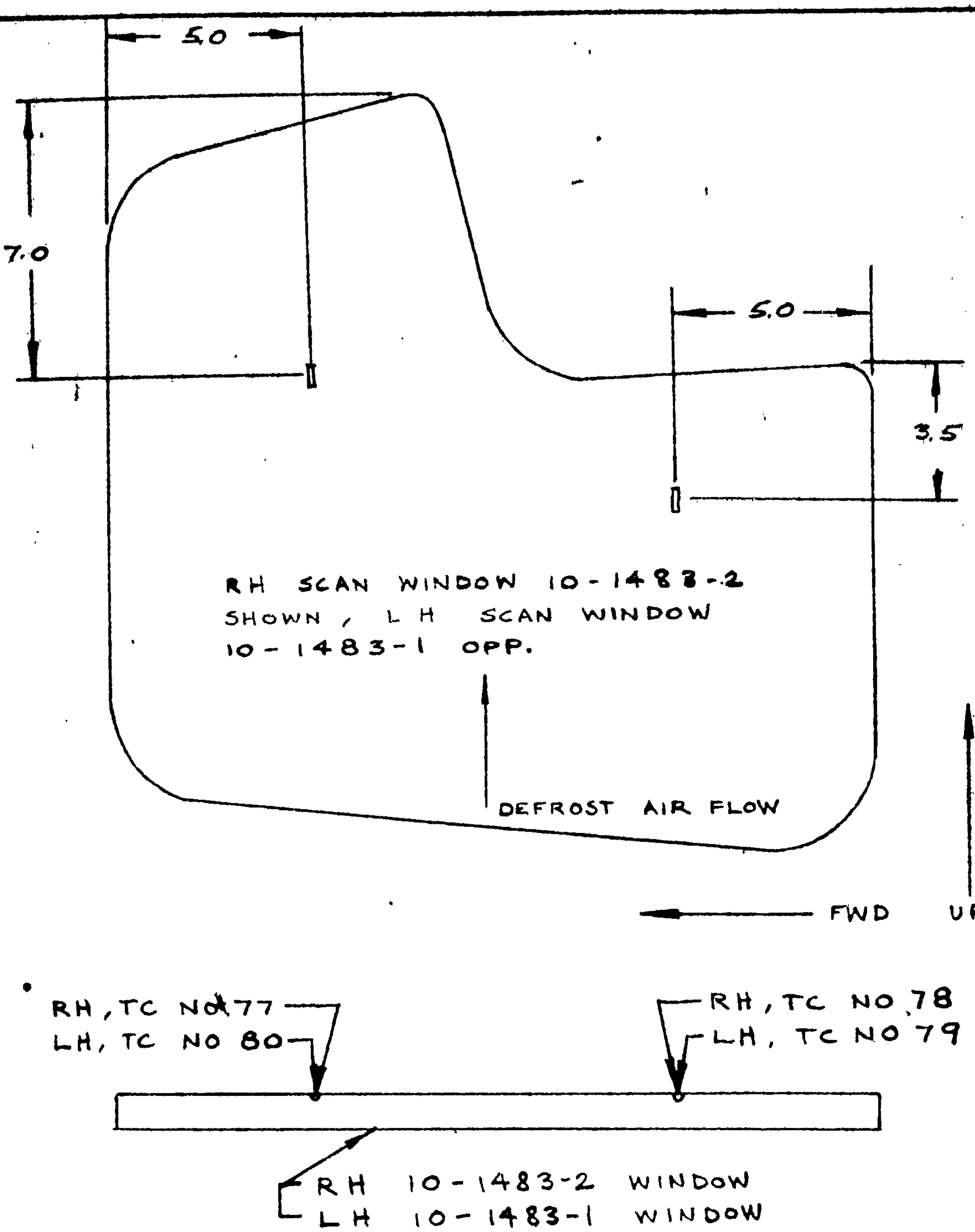
REDRAWN FROM WD 13563, P. 4.4.75.

CALC	JM	7-7-4	REVISED	DATE	FLIGHT TEST INSTRUMENTATION - INSIDE SURFACE TEMPERATURE, NOSE COVER WINDOW
CHECK	M. PECHT	6-55			
APR					BOEING AIRPLANE COMPANY
APR					WICHITA DIVISION — WICHITA 1, KANSAS

FIGURE 52
RB-47E
WD-14018

CONTRACT NO.

FORM E-582



RH TC'S NO 77 + 78 ; LH TC'S NO 79 + 80

INSIDE SURFACE TEMPERATURES, RIGHT AND LEFT HAND SCAN WINDOWS

REDRAWN FROM WD 13563, P. 4.4.77

			REVISED	DATE		
CALC	[illegible]	7-7-4			FLIGHT TEST INSTRUMENTATION - INSIDE SURFACE TEMPERATURE, R.H. AND L.H. SCAN WINDOWS	FIGURES 53
CHECK	M. PECHT	6-55				RB-47E
APR					BOEING AIRPLANE COMPANY	WD-14018
APR					WICHITA DIVISION WICHITA 1, KANSAS	PAGE 104

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FORM E-582

SUPPLEMENT A

CALCULATION OF COMPARTMENT DEW POINT TEMPERATURE

The cabin air conditioning airflow was not measured during the WFT 709 defrosting flight tests. As previously noted, an attempt to measure the compartment dew point during the flight tests was unsuccessful. In view of the foregoing, the compartment dew point temperature range will be determined by an approximate method. Since the air conditioning airflow rate into the cabin was not measured, a maximum and minimum airflow rate will be assumed, that is, the maximum airflow through the flow control valve and the minimum airflow required to maintain cabin pressure.

The defrost specification MIL-T-5842A (Reference 1) specifies that moisture addition from personnel in an occupied compartment be based on 0.5 lbs of H_2O/Hr per occupant. It is believed that this moisture addition rate is based on a 75°F environmental temperature. The navigator's compartment temperature averaged approximately 40°F during high altitude flight so consideration will be given to the reduced rate of moisture addition as a result of a colder environmental temperature.

Required: Determine compartment dew point temperature based on:

A. Maximum airflow rate and MIL-T-5842A moisture addition

B. Maximum airflow rate and revised moisture addition

C. Minimum airflow rate and MIL-T-5842A moisture addition

D. Minimum airflow rate and revised moisture addition

Given:

1. Airplane altitude = approximately 39,000 feet

2. Ambient air moisture content (100% saturated per MIL-T-5842A) M_a = 2 grains/lb dry air

3. Cabin pressure = 19.27 In.Hg.abs. (measured in flight test)

Calculations:

A. Maximum airflow rate and MIL-T-5842A moisture addition
Maximum flow through control valve

$W = 230 \left(P_{s1}/T_1\right)^{\frac{1}{2}}$ (Page 50 of D-13341, Reference 16)

W = airflow, lbs./min.

P_{s1} = pressure upstream of valve, psia

CALC	JGK	10-22-55	REVISED	DATE	CALCULATION OF COMPARTMENT DEW POINT TEMPERATURE	Suppl. A
CHECK						RB-47E
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T_1 = absolute temperature upstream of valve °R

Average values from flight test data

P_{s_1} = 39.8"Hg.abs = 19.55 psia

T_1 = 207°F = 667°R

$W = 230 \left(19.55/667\right)^{\frac{1}{2}}$

W = 39.6 lbs/min

Moisture added by crew per MIL-T-5842A

$M = 0.5 \times 3 = 1.5$ lbs/H_2O/Hr

Moisture addition on grains/lb dry air basis

$M = \dfrac{1.5 \times 7000}{39.6 \times 60} = 4.42$ grains /lb dry air

Specific moisture content of compartment air

$M_T = M + M_a$

$M_T = 4.42 + 2 = 6.42$ grains/lb dry air

Compartment Dew Point can be determined by the following equation:

$M_T = 0.622 \dfrac{P_s}{P_b - P_s} (7000) = \dfrac{4354 P_s}{P_b - P_s}$ (Page 34 of Reference 17)

M_T = specific moisture content of air = 6.42 grains/lb dry air

P_B = ambient pressure (cabin) = 19.27"Hg.abs.

P_s = vapor pressure of saturated air, "Hg.

$6.42 = \dfrac{4354\ P_s}{19.27 - P_s}$

$P_s = \dfrac{123.6}{4360.42} = .0284$"Hg. = .0139 psi

From a vapor pressure chart the temperature corresponding to this pressure is - 5.5°F

B. Maximum airflow rate and revised moisture addition

It is assumed that the moisture addition rate in MIL-T-5842A is based on a 75°F environmental temperature. However, the navigator's

CALC	JSK	10-22-55	REVISED	DATE	CALCULATION OF COMPARTMENT DEW POINT TEMPERATURE	Suppl. A RB-47E WD-14018
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APR					WICHITA DIVISION WICHITA 1, KANSAS	PAGE 106
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compartment was approximately 40°F at an altitude of 39,000 feet, and consequently it is believed the moisture addition by the navigator will be at a lesser rate than 0.5 lbs of H_2O/Hr or 3500 grains/Hr. Curve B, Figure 7, Page 122 of the Heating Ventilating Air Conditioning Guide, Reference 10, is considered to be the basis for the requirements of MIL-T-5842A. The environmental temperature for the pilot and copilot is assumed design or 75°F.

The moisture added by occupants then becomes

ΔM = 7900 grains/Hr.

The compartment dew point using 7900 grains/Hr moisture addition is calculated by the method of Paragraph A and found to be -9.2°F.

C. Minimum airflow rate and MIL-T-5842A moisture addition

The compartment dew point will be calculated using the minimum airflow rate required to maintain cabin pressure. The minimum airflow rate was determined to be approximately 13 lbs/min based on a leakage rate of 300 cfm presented in WD-14014 (Reference 12).

(a) The airflow rate was calculated by the following method.

For non-critical flow through an orifice

$$w = 27.90\, P_1 A \; \frac{(1 - r^2)^{\frac{1}{2}}}{(T_1)^{\frac{1}{2}}} \quad *$$

w = airflow rate lbs/min

P_1 = upstream static pressure, PSIA

P_2 = downstream static pressure, PSIA

A = orifice area, In^2

r = pressure ratio, P_2/P_1

T_1 = upstream temperature, °R

The conditions for the leakage rate of 300 cfm were as follows:

P_a = 29.25 "Hga

ΔP = 6.55 psi

t_c = 58°F (cabin temperature)

CALC	JKK	10-23-58	REVISED	DATE	CALCULATION OF COMPARTMENT DEW POINT TEMPERTATURE	Suppl. A
CHECK						RB-47E
APR					BOEING AIRPLANE COMPANY	WD-14018
APR					WICHITA DIVISION WICHITA 1, KANSAS	PAGE 107
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$t_a = 45°F$ (ambient temperature)

The leakage rate in lbs/min is then

$$w = Q \rho$$

$$Q = 300 \text{ cfm}$$

$$\rho = 1.327 \times \frac{29.25}{518} = 0.075 \ \#/ft^3$$

$$w = 300 \times .075 = 22.5 \ \#/min$$

Substituting this airflow into the non-critical flow equation the orifice area can be determined

$$w = 22.5 \ \#/min$$

$$P_1 = 29.25 \text{ "Hga} + \Delta P = 14.35 + 6.55 = 20.9 \text{ psia}$$

$$P_2 = 29.25 \text{ "Hga} = 14.35 \text{ psia}$$

$$r = 14.35/20.9 = .687$$

$$T_1 = 518 \ °R$$

$$22.5 = 27.90 \times 20.9 \ A \ \frac{\left[1-(.687)^2\right]^{\frac{1}{2}}}{(518)^{\frac{1}{2}}}$$

$$A = \frac{22.5 \times (518)^{\frac{1}{2}}}{27.90 \times 20.9 \left[1-(.687)^2\right]^{\frac{1}{2}}}$$

$$A = \frac{22.5 \times 22.75}{27.9 \times 20.9 \times .727}$$

$$A = 1.205 \text{ In}^2$$

Substituting this value into the following equation for critical flow the airflow at 39,000 ft is obtained

$$W = P_1 A \ 60 \ (.449 + .241 \ r) \ \frac{(1-r)^{\frac{1}{2}}}{(T_1)^{1/2}} \quad *$$

$$P_1 = 6.55 + P_a$$

P_a = ambient pressure at 39,000 ft. = 5.812" Hga = 2.85 psia

$$P_1 = 6.55 + 2.85 = 9.10 \text{ psia}$$

$$A = 1.205 \text{ In}^2$$

$$r = P_2/P_1 = 2.85/9.10 = .313$$

CALC	JBK	10-22-55	REVISED	DATE	CALCULATION OF COMPARTMENT DEW POINT TEMPERATURE	Suppl. A
CHECK						RB-47E
APR					BOEING AIRPLANE COMPANY	WD-14018
APR					WICHITA DIVISION — WICHITA 1, KANSAS	PAGE 108
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$P_2 = 2.85$ psia

$T_1 = 500$ °R

$$W = 9.10 \times 1.205 \times 60\ (.449 + .241 \times .313)\ \frac{(1 - .313)^{\frac{1}{2}}}{(500)^{\frac{1}{2}}}$$

$$W = 9.1 \times 1.205 \times 60\ (.449 + .0755)\ \frac{(.829)}{22.35} = 12.8 \text{ lb/min}$$

* Formulae taken from ASME Transactions, 1949, Volume 71

Using the method of Paragraph A the calculated dew point was 11.5 °F for minimum airflow and MIL-T-5842A moisture addition.

D. Minimum airflow rate and revised moisture addition

The calculated dew point was 7.2 °F for minimum airflow and moisture addition rate of 7900 grains/Hr.

INSERT NO. 1

BOEING AIRPLANE COMPANY

Document WD-13563

TITLE: Instrumentation for Navigator's
Compartment Defrosting System -
Flight Test RB-47E-AF 51-5258

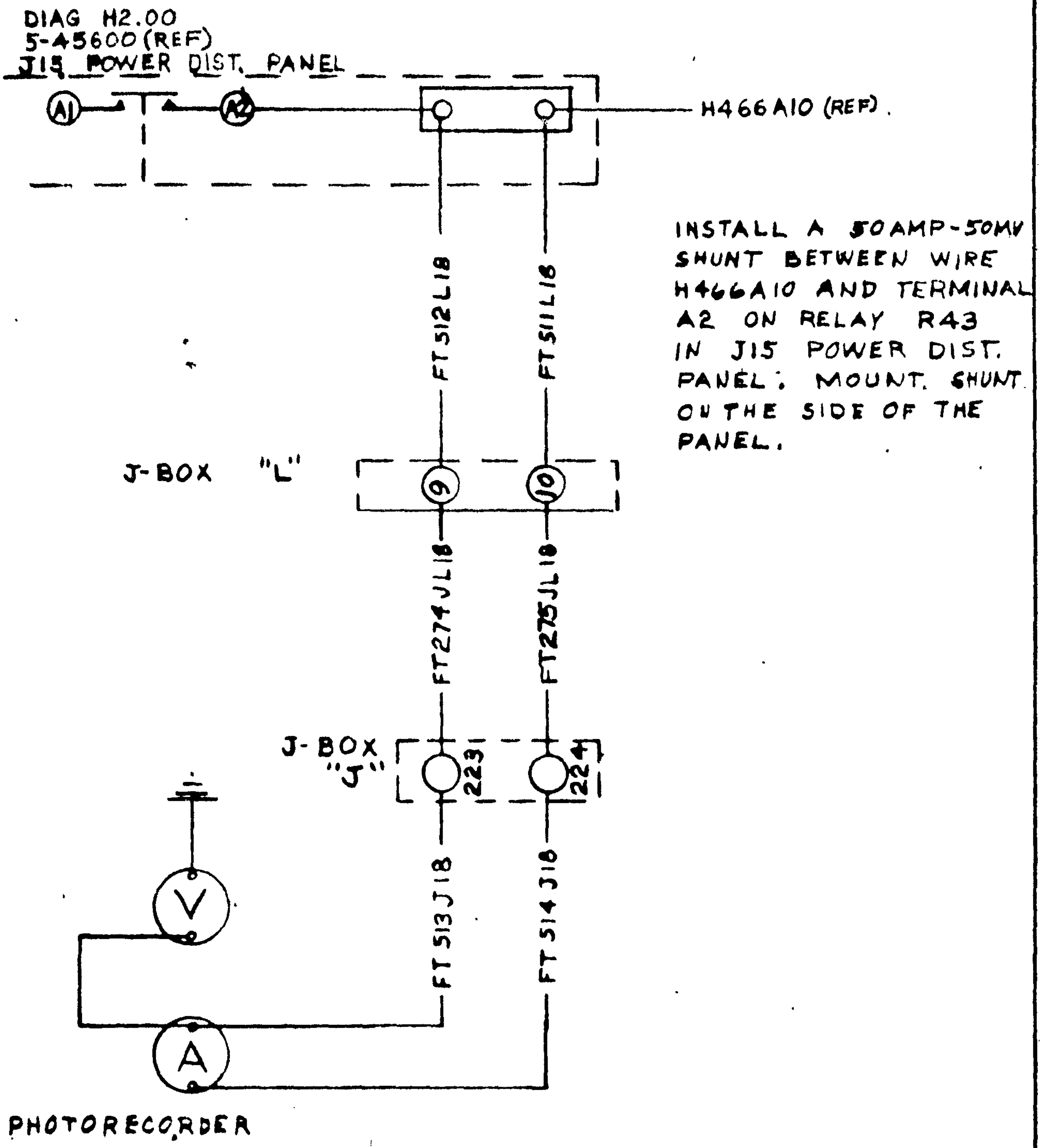
Applicable pages of document WD-13563 not
including Figures 41 through 53 of WD-14018

Pages: 4.3.3
4.3.4
4.3.6 through 4.3.9
4.3.12
4.3.13
4.4.49
4.4.50
4.4.52 through 4.4.58
4.4.60
4.4.61
4.4.79
4.4.81 through 4.4.83
4.6.13
4.6.24
5.4.21

Pages 111 to 136

CALC	JBK	10-22-55	REVISED	DATE	INSERT NO. 1 INSTRUMENTATION FOR NAVIGATORS COM- PARTMENT DEFROSTING SYSTEM FLIGHT TEST AF 51-5258	Insert No. 1
CHECK						RB-47E
APR					BOEING AIRPLANE COMPANY	WD-14018
APR					WICHITA DIVISION WICHITA 1, KANSAS	PAGE
CONTRACT NO.					Insert No. 1 WD-14018	110

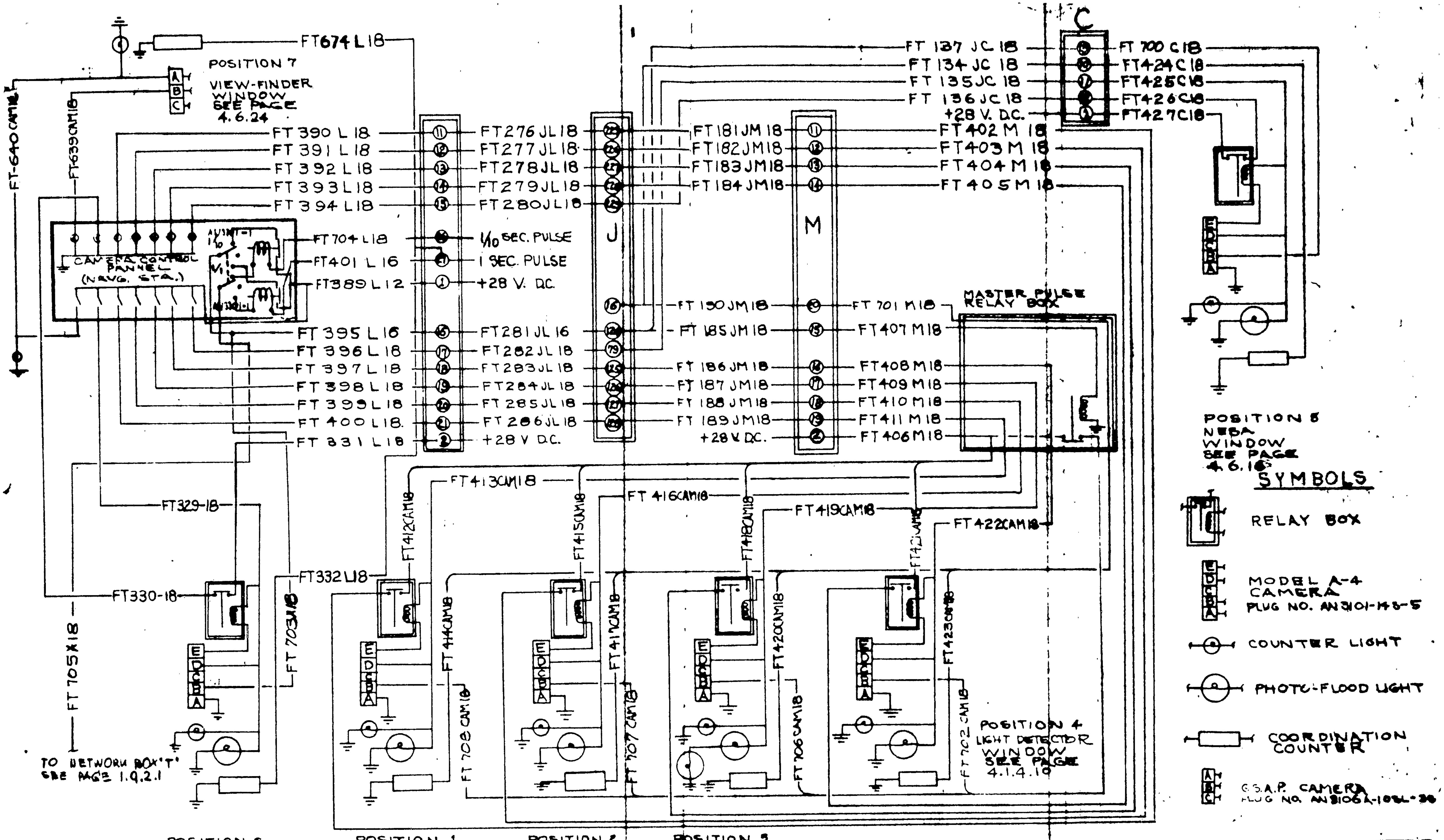
FORM E-582



3.3 VOLTAGE AND CURRENT - CABIN DEFROST BLOWER

CALC	EWN	7-29-53	REVISED	DATE	CAMERA COMPARTMENT AND CABIN DEFROSTING SYSTEM	RB-47E 51-5258
CHECK		9-10-53				WD 13563
APR		3/15/54			BOEING AIRPLANE CO.	
APR					WICHITA DIVISION — WICHITA 1, KANSAS	PAGE
CONTRACT NO.					Insert No. 1 WD-14018 Page 111	4.3.3

E-1196



3.4 CAMERA INSTL. - DEFROSTING SYSTEM

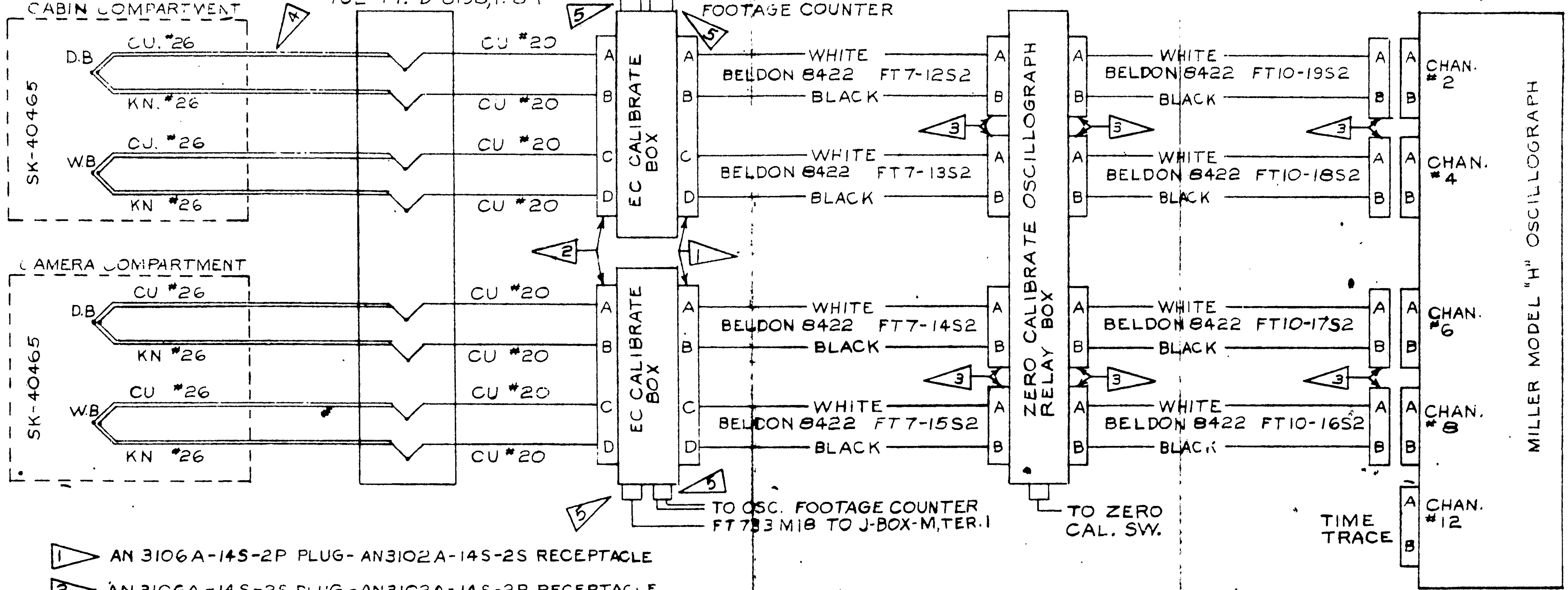
CALC	JFS	8-20-53	REVISED	DATE
CHECK	[illegible]	12-31-53		
APR	[illegible]	3/13/54		
APR				
CONTRACT No.				

CAMERA COMPARTMENT AND CABIN DEFROSTING SYSTEM

BOEING AIRPLANE COMPANY
SEATTLE 14, WASHINGTON

Insert No. 1 WD-14018 Page 112

3.6 CABLE DIAGRAM - HUMIDITY PICKUP



1. AN 3106A-14S-2P PLUG - AN3102A-14S-2S RECEPTACLE
2. AN 3106A-14S-2S PLUG - AN3102A-14S-2P RECEPTACLE
3. AN 3106A-10SL-4S PLUG - AN3102A-10SL-4P RECEPTACLE
4. THERMOELECTRIC CU-KN DUPLEX THERMOCOUPLE WIRE IN PARALLEL TO ICE POINT

NOTE: FE-KN USED UP TO TEST 8-1
NOTE: FOR WIRING DIAGRAM OF EC CALIBRATE BOX SEE WD 12829, P. 162

5. AN 3106-12S-3S PLUG - AN3102A-12S-3P RECEPTACLE

(INSTALLATION SEE PAGE 4.4.82)

CALC	JMc	3-3-54	REVISED	DATE
CHECK	[signature]	3-3-54	JMc	4/8/54
APR	[signature]	3/15/54		
APR				
CONTRACT No.				

CAMERA COMPARTMENT AND CABIN DEFROSTING SYSTEM

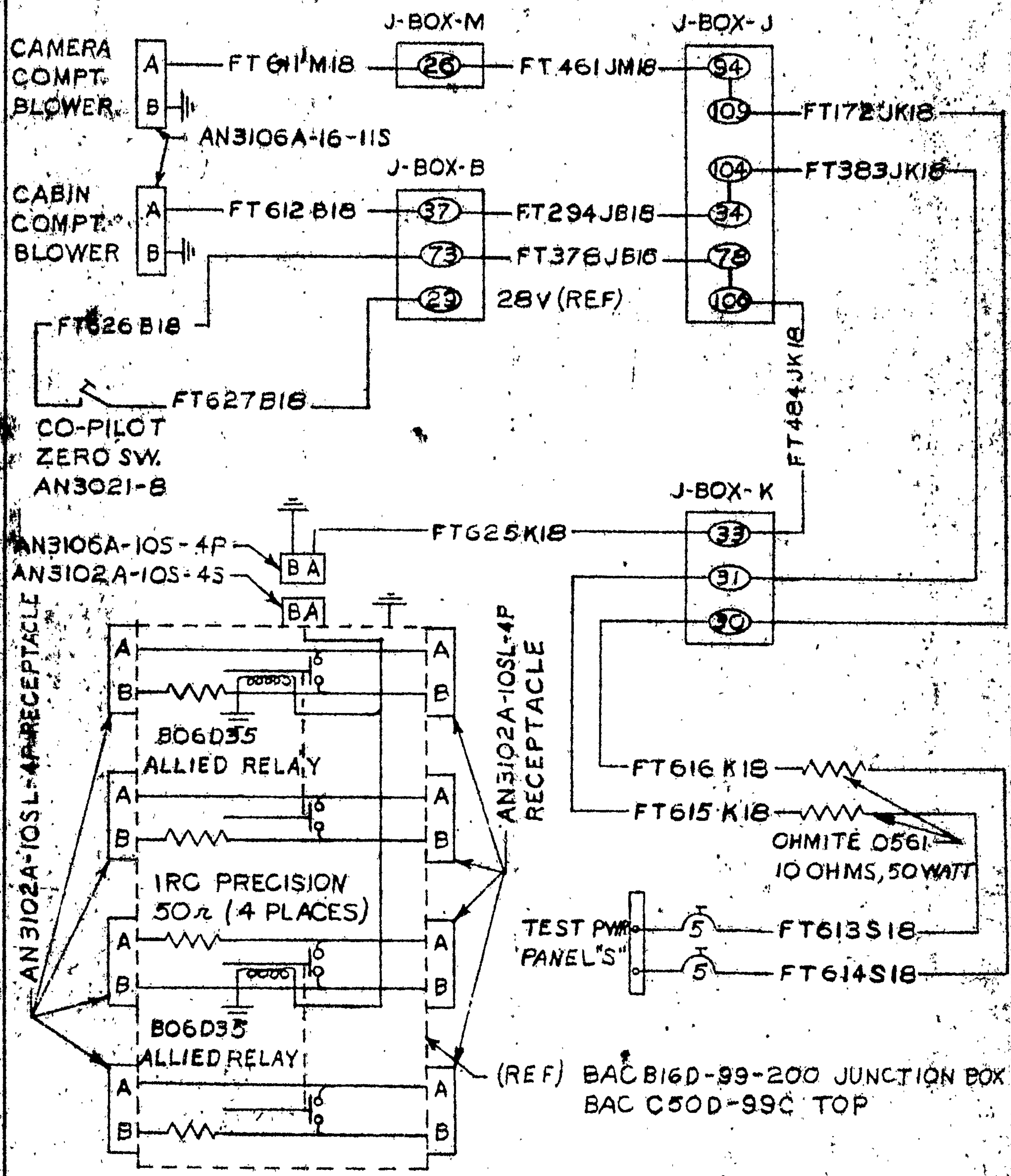
BOEING AIRPLANE COMPANY
SEATTLE 14, WASHINGTON

RB-47E 51-5258
WD 13563
PAGE 4.3.6 OF

BAC 1000-R1

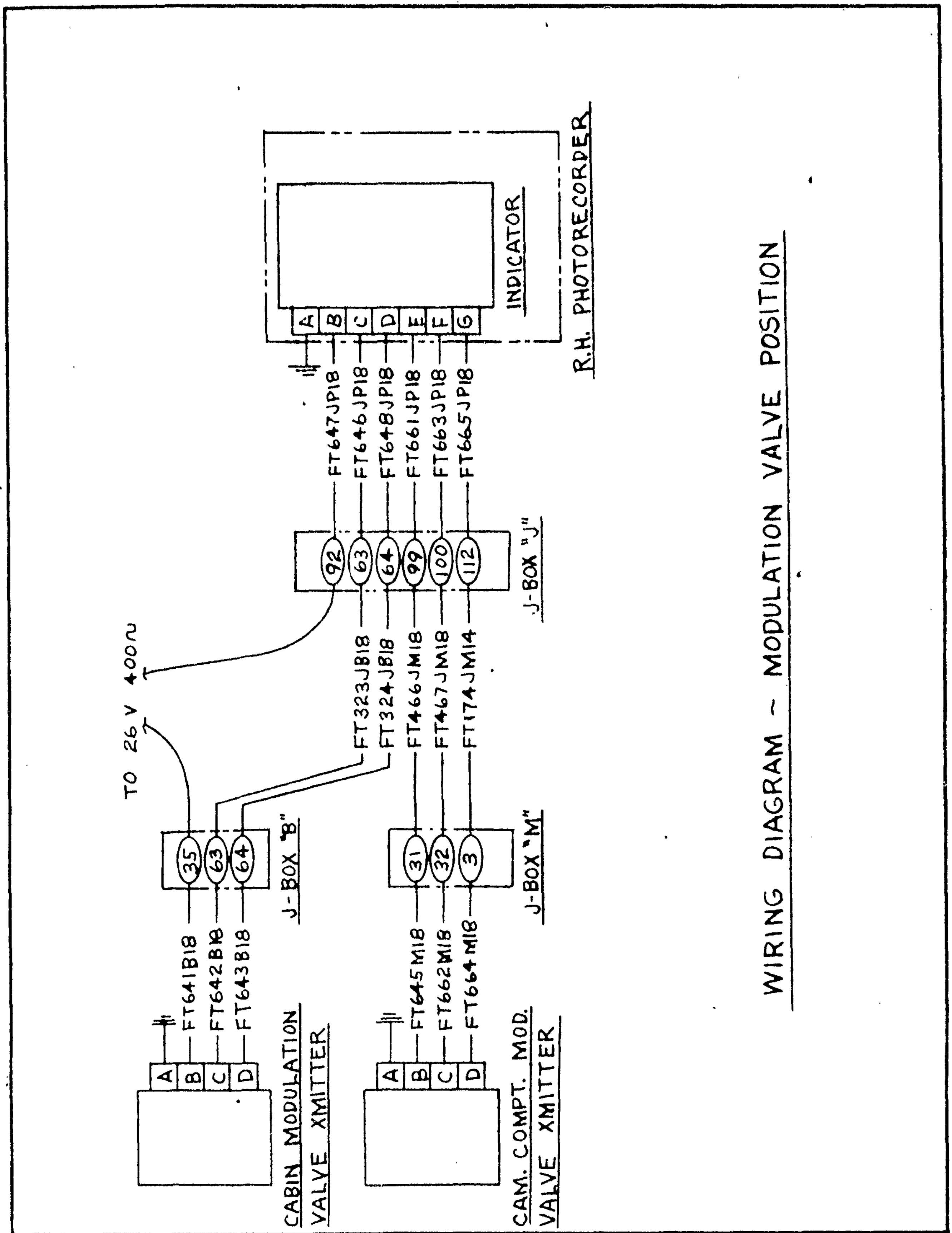
3.7 WIRING DIAGRAM - HUMIDITY PICKUP

(INSTALLATION SEE PAGE 4.4 82)

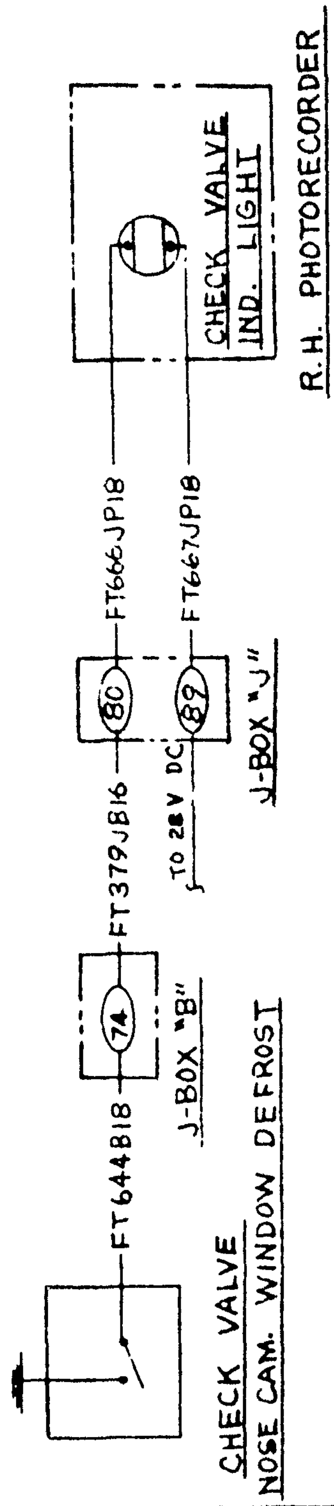


ZERO CAL. OSCILLOGRAPH RELAY BOX

CALC	JM	9/25/53	REVISED	DATE	CAMERA COMPARTMENT AND CABIN DEFROSTING SYSTEM	RB-47E 51-5258
CHECK	[illegible]	[illegible]				
APR	[illegible]	3/15/54				WD-13563
APR					BOEING AIRPLANE CO. WICHITA DIVISION WICHITA 1, KANSAS	
CONTRACT NO.					Insert No. 1 WD-14018 Page 114	PAGE 4.3.7

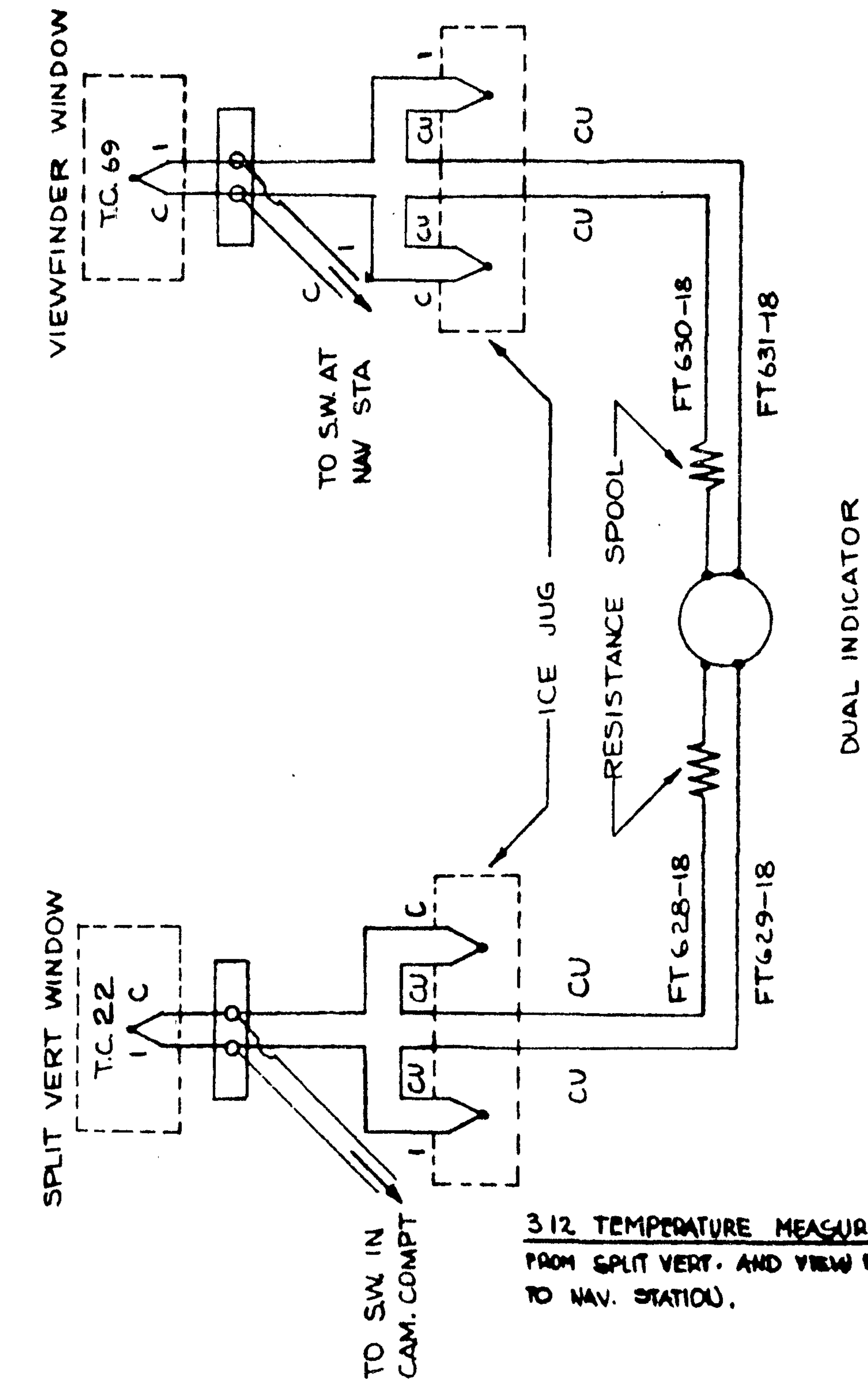


			REVISED	DATE		
CALC	KUHN	10-19-53			CAMERA COMPARTMENT AND CABIN DEFROSTING SYSTEM	RB-47E AF51-5258
CHECK	[illegible]	11-10-53				
APR	[illegible]	3/15/54			BOEING AIRPLANE CO.	WD-13563
APR					WICHITA DIVISION WICHITA 1, KANSAS	PAGE
CONTRACT NO.					Insert No. 1 WD-14018 Page 115	4.3.8



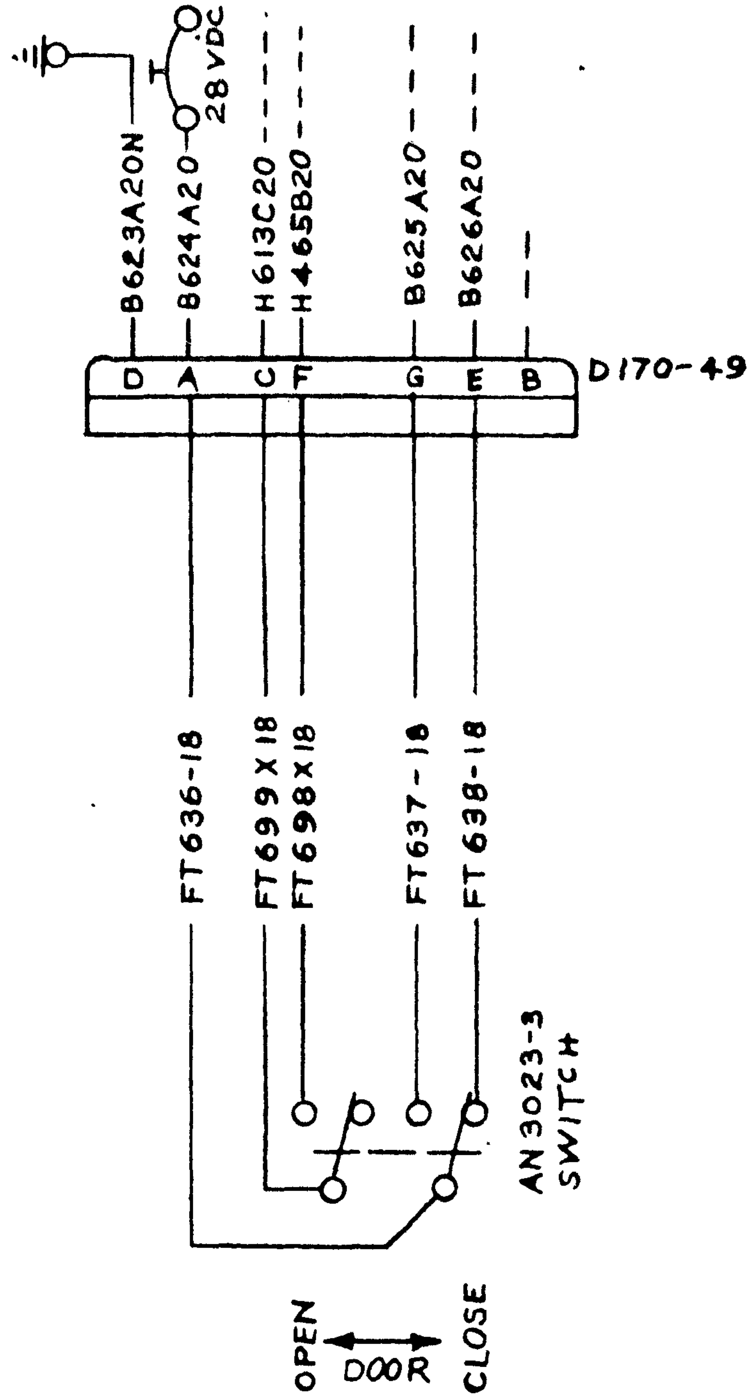
WIRING DIAGRAM ~ CHECK VALVE POSITION

			REVISED	DATE		
CALC	KUHN	10-19-53			CAMERA COMPARTMENT AND CABIN DEFROSTING SYSTEM	RB-47E AF51-5258
CHECK	[illegible]	1-10-53				WD-13563
APR	B. B.	3/15/54			BOEING AIRPLANE CO.	
APR					WICHITA DIVISION WICHITA 1, KANSAS	PAGE
CONTRACT NO.					Insert No. I WD-14018 Page 116	4.3.9



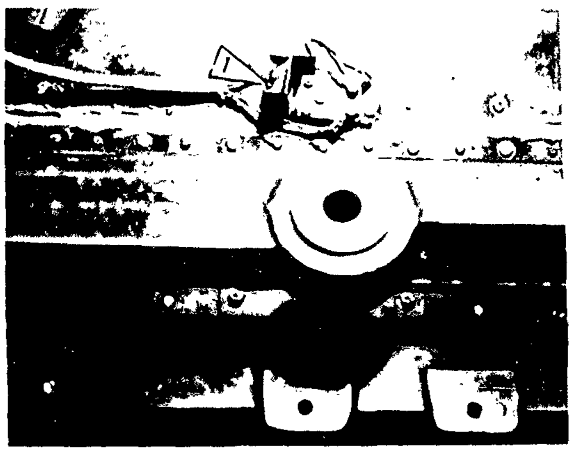
3.12 TEMPERATURE MEASUREMENTS AT NAV. STA
FROM SPLIT VERT. AND VIEW FND. WINDOWS
TO NAV. STATION.

CALC	J.P.C.	10-1-53	REVISED	DATE	CAMERA COMPARTMENT AND CABIN DEFROSTING SYSTEM	RB-47E 51-5258
CHECK	E.N.	10-1-53				
APR	R.B.	3/13/54				WD-13563
APR					BOEING AIRPLANE CO.	
					WICHITA DIVISION WICHITA 1, KANSAS	PAGE
CONTRACT NO.					Insert No. 1 WD-14018 Page 117	403.12



3.13 VIEWFINDER DOOR OPERATION (VIEWFINDER REMOVED)

CALC	11-17-53	E.N.	REVISED	DATE	CAMERA COMPARTMENT AND CABIN DEFROSTING SYSTEM	RB-47E 51-5258
CHECK	[illegible]	2-3-54				WD-13563
APR	[illegible]	2/15/54			BOEING AIRPLANE CO.	
APR					WICHITA DIVISION WICHITA 1, KANSAS	PAGE
CONTRACT NO.					Insert No. 1 WD-14018 Page 118	4.3.13



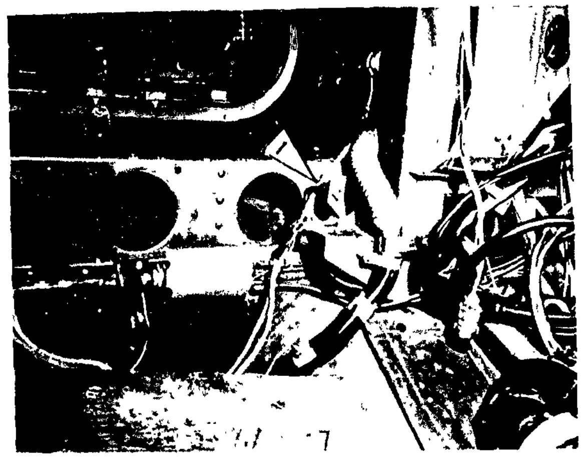
FTW 5499

1> SK-40337 THERMOCOUPLE - ENVIRONMENTAL
Attach to structure at approx. Sta 46.0
WL.118, BLO.

1.2.49 T-C Cabin Average Air Temperature
1.2.50 T-C Cabin Average Temperature (Not Shown)
Identical to 1.2.18 TC-Navigator's station
page 5.4.21 this document.

BW-104121

			REVISED	DATE		
CALC	DA My	5-4-54			CAMERA COMPARTMENT AND CABIN DEFROSTING SYSTEM.	RB-47E 51-5258
CHECK						WD-13563
APR	R.P.	5/15/54			BOEING AIRPLANE CO.	
APR					WICHITA DIVISION WICHITA 1, KANSAS	PAGE
CONTRACT NO.					INSERT NO. W[illegible] PAGE [illegible]	4.4.40



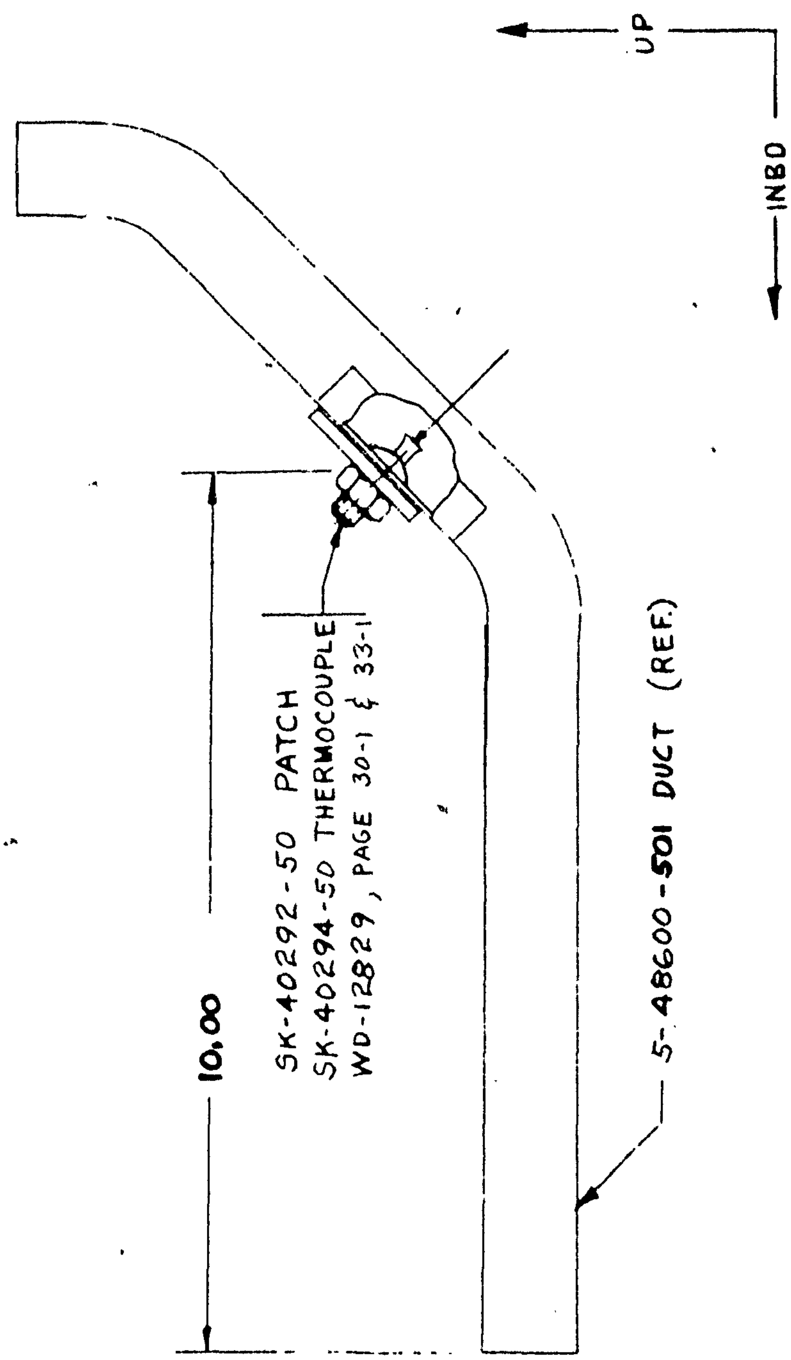
FTW 5498

1 SK-40286 FITTING-STATIC
Mount pickup to small bracket AL-Alloy .064 x 1.0 x 1.0 x 2.0. Locate bracket at approx. Sta 95, WL 106, RBL 10.

1.1.4 Cabin Static Pressure Near Blower Inlet BW-104120

			REVISED	DATE		
CALC	[illegible]	2-5-54			CAMERA COMPARTMENT AND CABIN DEFROSTING SYSTEM	RB-47E 51-5258
CHECK	[illegible]	2/11/54				WD-13563
APR	[illegible]	3/15/54			BOEING AIRPLANE CO.	
APR					WICHITA DIVISION WICHITA 1, KANSAS	PAGE 4.4.50
CONTRACT NO.					INSERT NO. WD 4018 PAGE 120	

T-C NO. 52
TEMPERATURE - VIEWFINDER WINDOW INSIDE SUPPLY DUCT

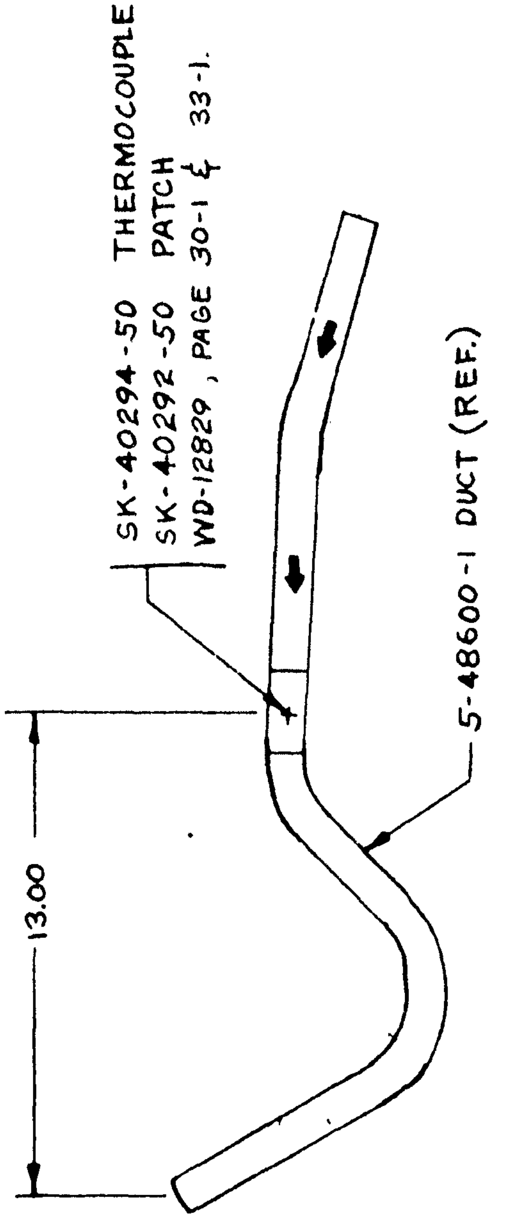


SEAL PER BAC 5000 TYPE XIV

1.2.52 T-C Viewfinder Supply Duct - Inside Defrost

CALC	KUHN	1-5-55	REVISED	DATE	CAMERA COMPARTMENT AND CABIN DEFROSTING SYSTEM	RB-47E 51-5258
CHECK		1-6-55				
APR	B/B	3/15/55			BOEING AIRPLANE CO.	WD-13563
APR					WICHITA DIVISION WICHITA 1, KANSAS	PAGE
CONTRACT NO.					Insert No. 1 WD-14018 Page 121	4.4.52

T-C NO. 53
NOSE CAMERA WINDOW INSIDE SUPPLY DUCT

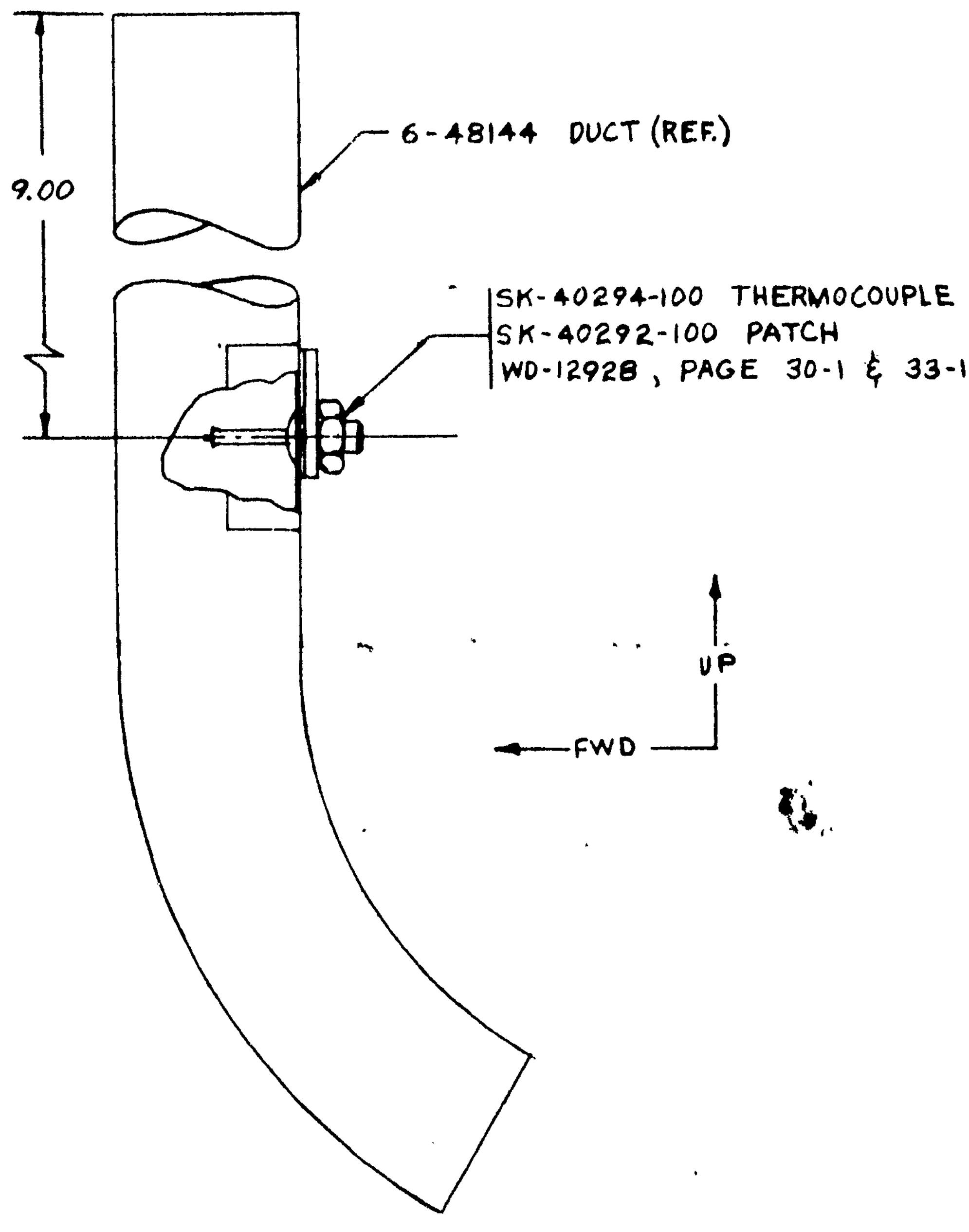


1.2.53 **T-C Nose Camera Window Supply Duct - Inside Defrost**

CALC	KUHN	1-6-53	REVISED	DATE	
CHECK	[illegible]	1-6-53			CAMERA COMPARTMENT AND CABIN DEFROSTING SYSTEM
APR	RJB	3/15/53			
APR					BOEING AIRPLANE CO. WICHITA DIVISION WICHITA 1, KANSAS
CONTRACT NO.					Insert No. 1 WD-14018 Page 122

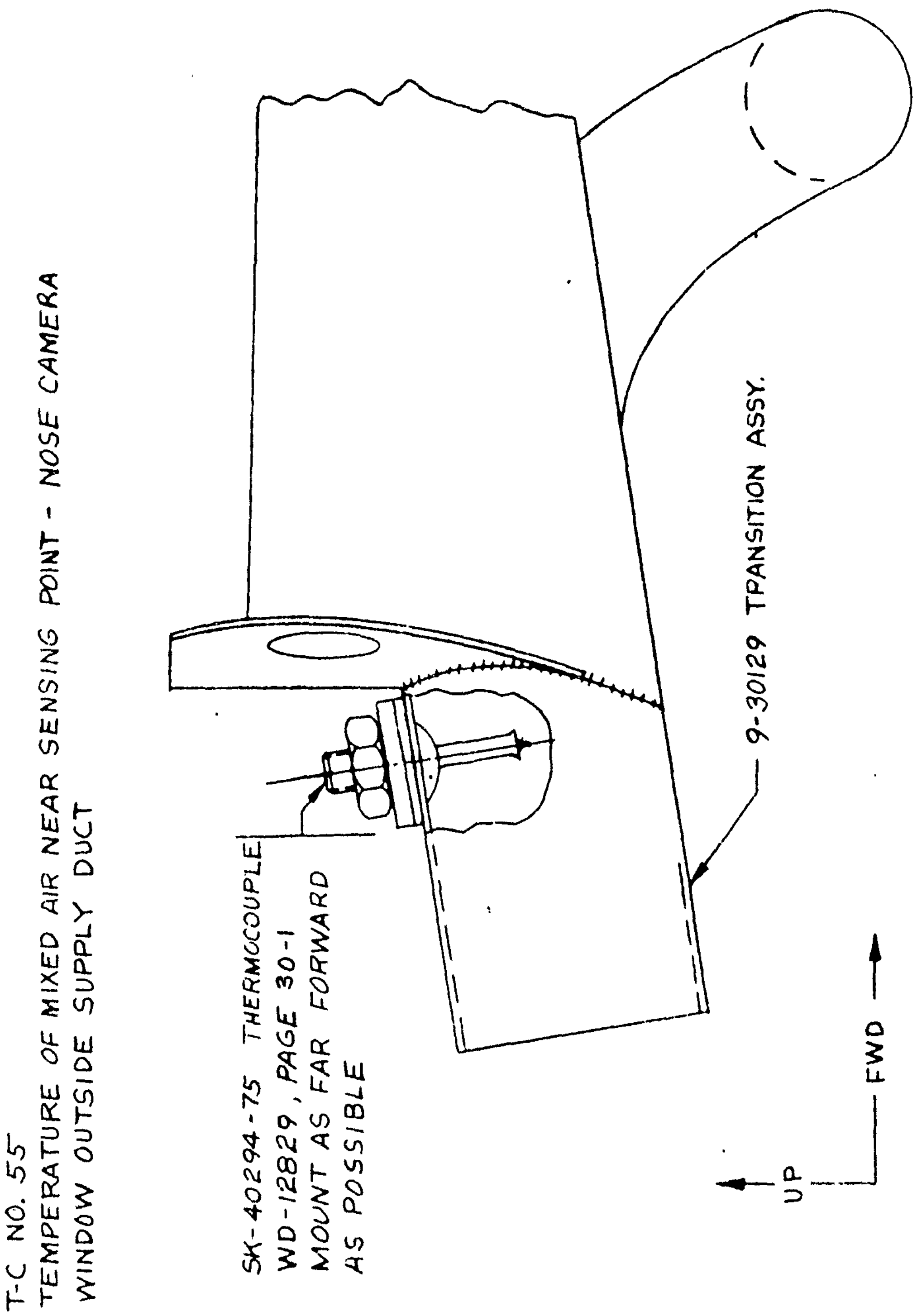
RB-47E 51-5258
WD-13563
PAGE 4.4.53

T-C NO. 54
TEMPERATURE - CAMERA VENTILATION



1.2.54 T-C Camera Ventilation Supply Duct

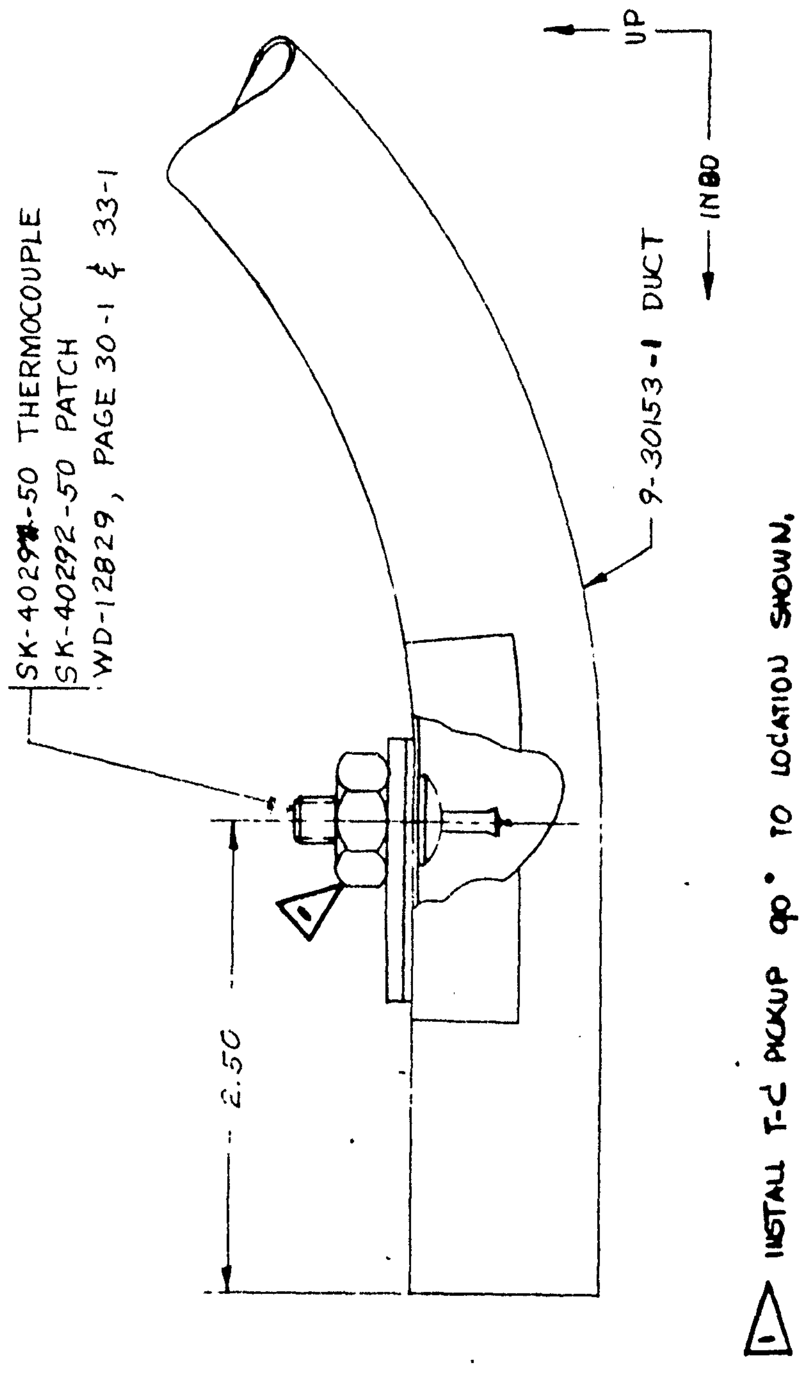
			REVISED	DATE		
CALC	KUHN	11-6-53			CAMERA COMPARTMENT AND CABIN DEFROSTING SYSTEM	RB-47E 51-5258
CHECK	[illegible]	11-5-53				WD-13563
APR	[illegible]	3/15/54			BOEING AIRPLANE CO.	
APR					WICHITA DIVISION WICHITA I, KANSAS	PAGE 4.4.54
CONTRACT NO.					Insert No. 1 WD-14018 Page 123	



1.2.55 **T-C Mixed Air Near Sensing Point**

CALC	KUHN	4-6-53	REVISED	DATE	CAMERA COMPARTMENT AND CABIN DEFROSTING SYSTEM	RB-47E 51-5258
CHECK	[illegible]	4-6-53				WD-13563
APR	[illegible]	3/15/53			BOEING AIRPLANE CO. WICHITA DIVISION WICHITA 1, KANSAS	
APR						PAGE
CONTRACT NO.					Insert No. 1 WD-14018 Page 134	4.4.55

T-C NO. 56
TEMPERATURE UPSTREAM OF CHECK VALVE - VIEWFINDER OUTSIDE SUPPLY DUCT



1.2.56 **T-C Viewfinder Supply Duct - Outside Defrost**

CALC	KUHN	11-6-53	REVISED	DATE	CAMERA COMPARTMENT AND CABIN DEFROSTING SYSTEM
CHECK	[illegible]	11-6-53			
APR	[illegible]	3/15/54			BOEING AIRPLANE CO.
APR					WICHITA DIVISION WICHITA 1, KANSAS
CONTRACT NO.					Insert No. 1 WD-14018 Page 125

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51-5258
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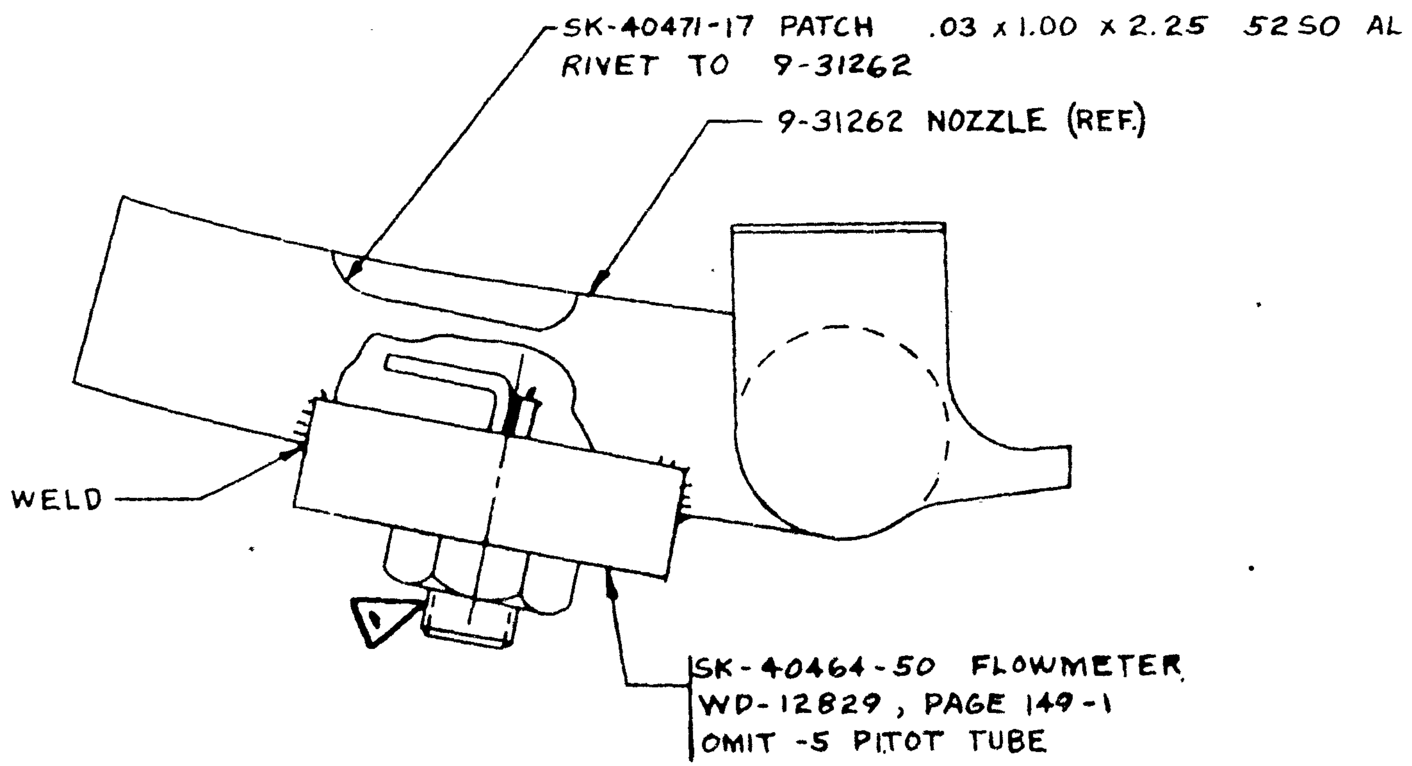
PAGE
4.4.56

T-C NO. 57, STATIC NO. 57
VIEWFINDER OUTSIDE SUPPLY DUCT - DOWNSTREAM OF CHECK VALVE

1.1.22 __Static Pressure, Viewfinder Supply Duct - Outside Defrost__
1.2.57 __T-C, Viewfinder Supply Duct - Outside Defrost__



1 INSTALL PICKUP ASSY. 90° TO LOCATION SHOWN.

SEAL PER BAC 5000 TYPE XIV
CUT OUT 9-31262 AS REQUIRED FOR INSTALLATION. PATCH CUTOUT WITH -17

CALC	KUHN	4-5-57	REVISED	DATE
CHECK	[illegible]	4-6-57		
APR	[illegible]	3/15/58		
APR				

CONTRACT NO.

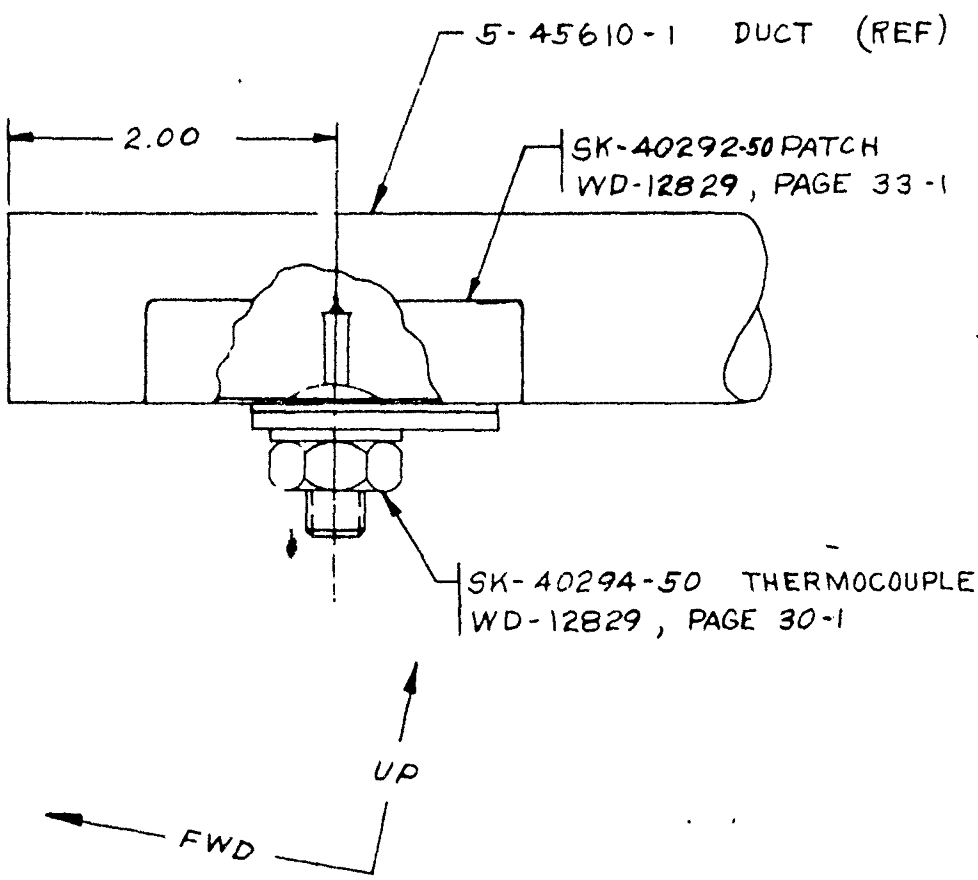
CAMERA COMPARTMENT AND CABIN
DEFROSTING SYSTEM

BOEING AIRPLANE CO.
WICHITA DIVISION WICHITA 1, KANSAS

RB-47E
51-5258
WD-
13563
PAGE
4.4.57

Insert No. 1 WD-14018 Page 136

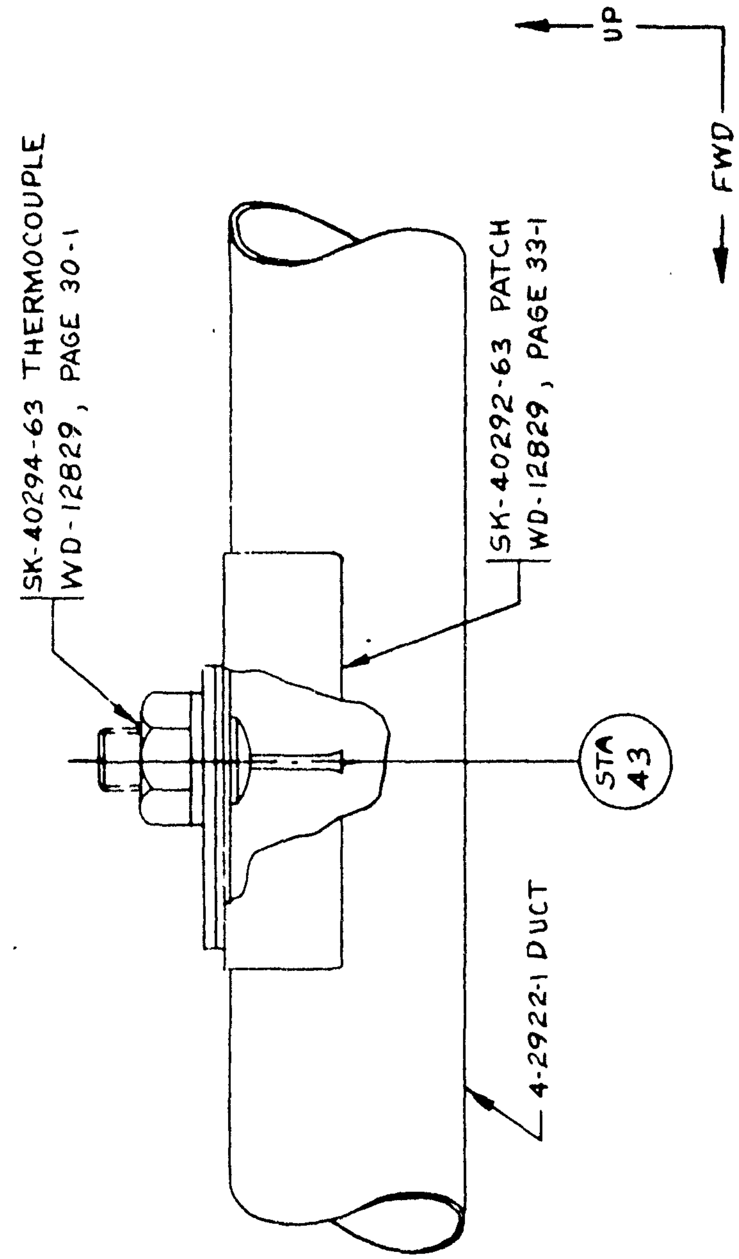
T-C NO. 58
TEMPERATURE UPSTREAM OF CHECK VALVE - NOSE
CAMERA WINDOW OUTSIDE SUPPLY DUCT.



1.2.58 T-C, Nose Camera Window Supply Duct - Outside Defrost

					CAMERA COMPARTMENT AND CABIN DEFROSTING SYSTEM	RB-47E 51-5258
CALC	KUHN	11-6-63	REVISED	DATE		
CHECK		11-6-63			BOEING AIRPLANE CO.	WD-13563
APR		3/15/54			WICHITA DIVISION WICHITA 1, KANSAS	PAGE
APR						
CONTRACT NO.					Insert No. 1 WD-14018 Page 127	4.4.58

T-C NO. 60
TEMPERATURE NEAR OUTLET - NOSE CANOPY SUPPLY DUCT

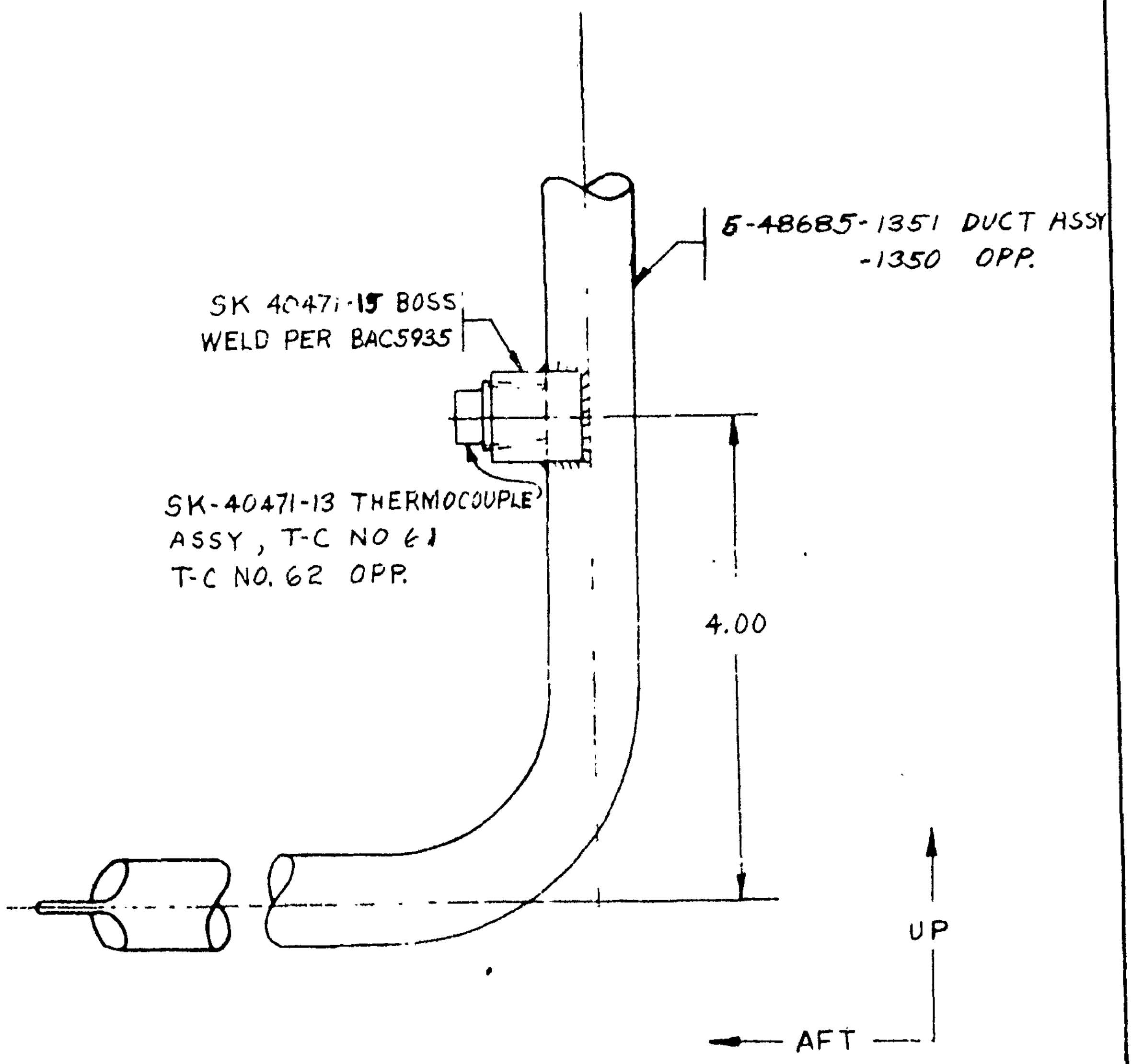


1.2.60 **T-C. Nose Cover Supply Duct Near Outlet**

CALC	KUHN	11-6-53	REVISED	DATE	CAMERA COMPARTMENT AND CABIN DEFROSTING SYSTEM	RB-47E 51-5258
CHECK		11-6-53				WD-13563
APR		3/15/54			BOEING AIRPLANE CO.	
APR					WICHITA DIVISION WICHITA 1, KANSAS	PAGE
CONTRACT NO.					Insert No. 1 WD-14018 Page 128	4.4.60

T-C NO. 61, T-C NO. 62
TEMPERATURE - NAVIGATOR'S WINDOW SUPPLY DUCT
L.H. INSTALLATION SHOWN - R.H OPPOSITE

1.2.62 T-H, L.H. Scan Window Supply Duct
1.2.61 T-H, R.H. Scan Window Supply Duct



FINISH: ZINC CHROMATE PRIMER ON -15

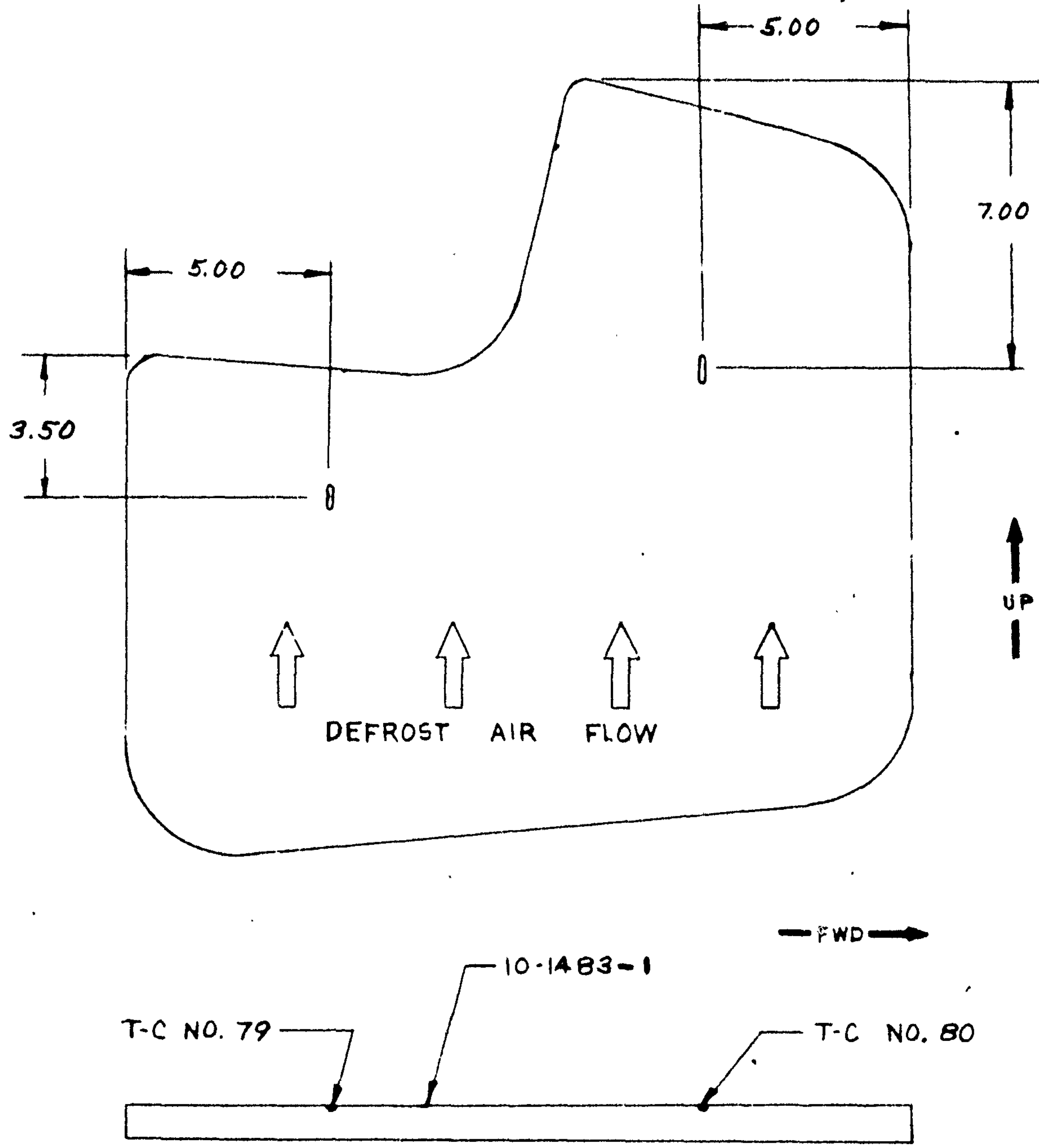
CALC	KUHN	1-6-54	REVISED	DATE	CAMERA COMPARTMENT AND CABIN DEFROSTING SYSTEM
CHECK	[illegible]	1-6-54			BOEING AIRPLANE CO.
APR	[illegible]	3/15/54			WICHITA DIVISION — WICHITA 1, KANSAS
APP					Insert No. 1 WD-14018 Page 129
CONTRACT NO.					

RB-47E 51-5258

WD-13563

PAGE 4.4.61

T-C NO. 79, T-C NO. 80
INSIDE SURFACE TEMPERATURE, LEFT HAND SCAN WINDOW
(FOR T-C INSTALLATION DETAILS SEE PAGE 4.5.5)



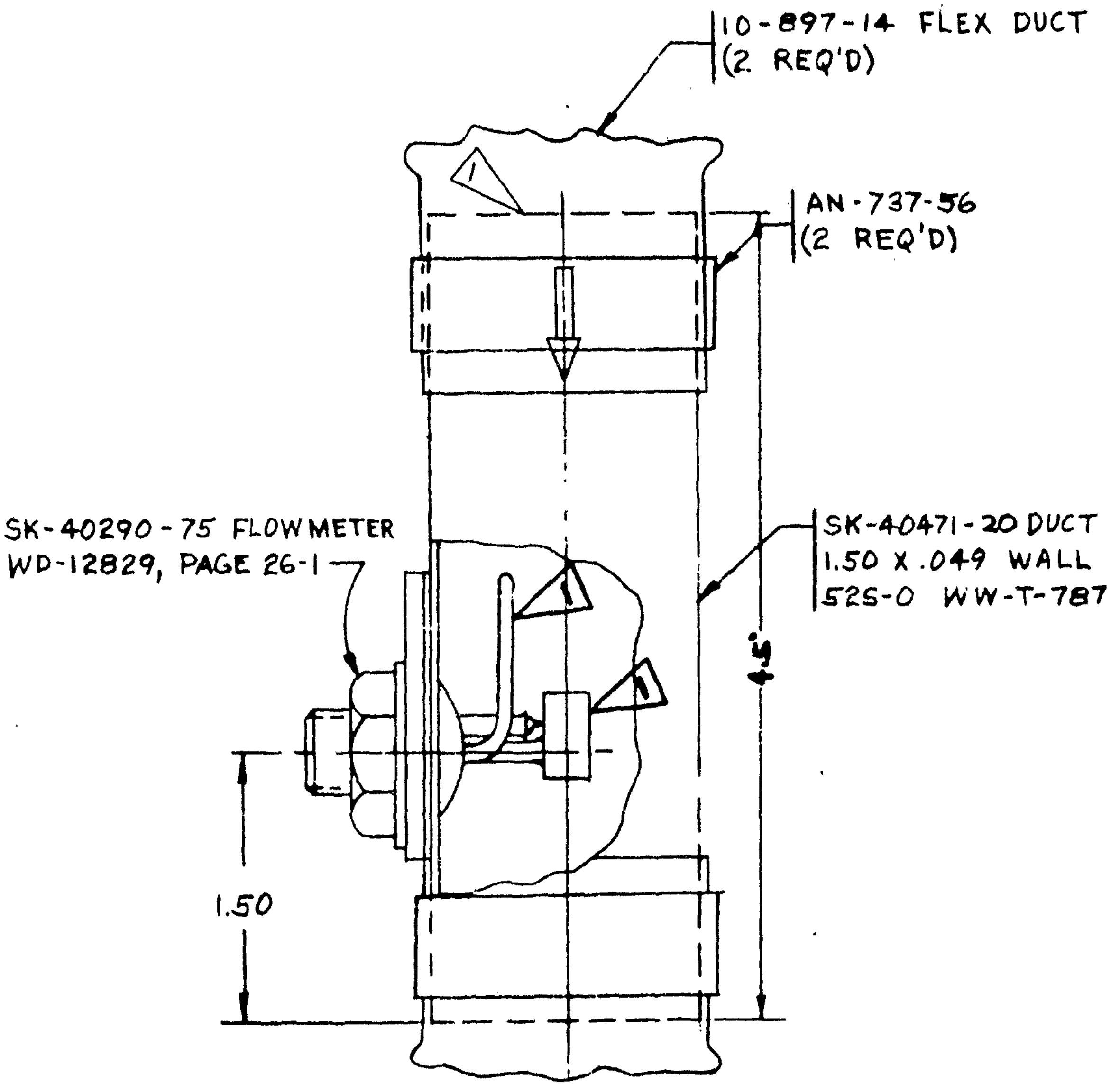
1.2.80 __T-C, Left Hand Scan Window Inside Surface__
1.2.79 __T-C, Left Hand Scan Window Inside Surface__

CALC	KUHN	1-6-55	REVISED	DATE	CAMERA COMPARTMENT AND CABIN DEFROSTING SYSTEM	RB-47E 51-5258
CHECK	[illegible]	1-6-55				WD-13563
APR	[illegible]	3/15/54			BOEING AIRPLANE CO.	
APR					WICHITA DIVISION WICHITA 1, KANSAS	PAGE 4.4.79
CONTRACT NO.					Insert No. 1 WD-14018 Page 130	

T-C NO. 81, STATIC NO. 81, PITOT NO. 81
MIXED AIR - UPSTREAM OF VENTURI

THIS INSTALLATION TO REPLACE 10-893-31 FLEX DUCT

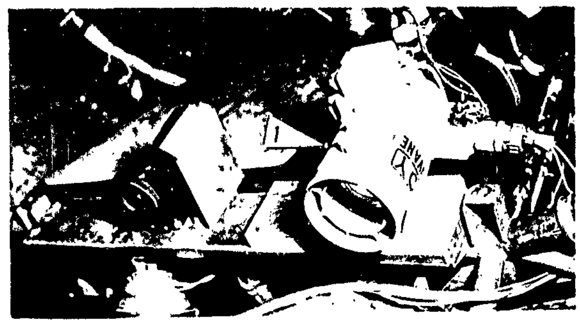
[1] CUT OFF THIS END OF -20 DUCT TO FIT ON INSTALLATION
SEAL PER MAC 5000 TYPE XIV



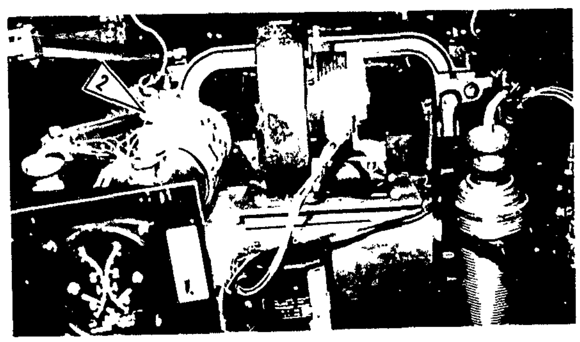
[1] 1.1.24 <u>Total Pressure, Mixed Air Flow to Outside Defrost</u>
[1] 1.1.25 <u>Static Pressure, Mixed Air Flow to Outside Defrost</u>
1.2.81 <u>T-C Mixed Air Duct to Outside Defrost</u>

[1] Deleted per Outline 0-709 Rev. C., See page 4.4.83 R

CALC	KUHN	8-6-53	REVISED	DATE	CAMERA COMPARTMENT AND CABIN DEFROSTING SYSTEM	RB-47E 51-5258
CHECK	[illegible]	8-6-53	[illegible]	9/6/54		WD-13563
APR	[illegible]	3/15/54			BOEING AIRPLANE CO.	
APR					WICHITA DIVISION WICHITA 1, KANSAS	PAGE 4.4.81
CONTRACT NO.					Insert No. 1 WD-14018 Page 131	



FTW 5294



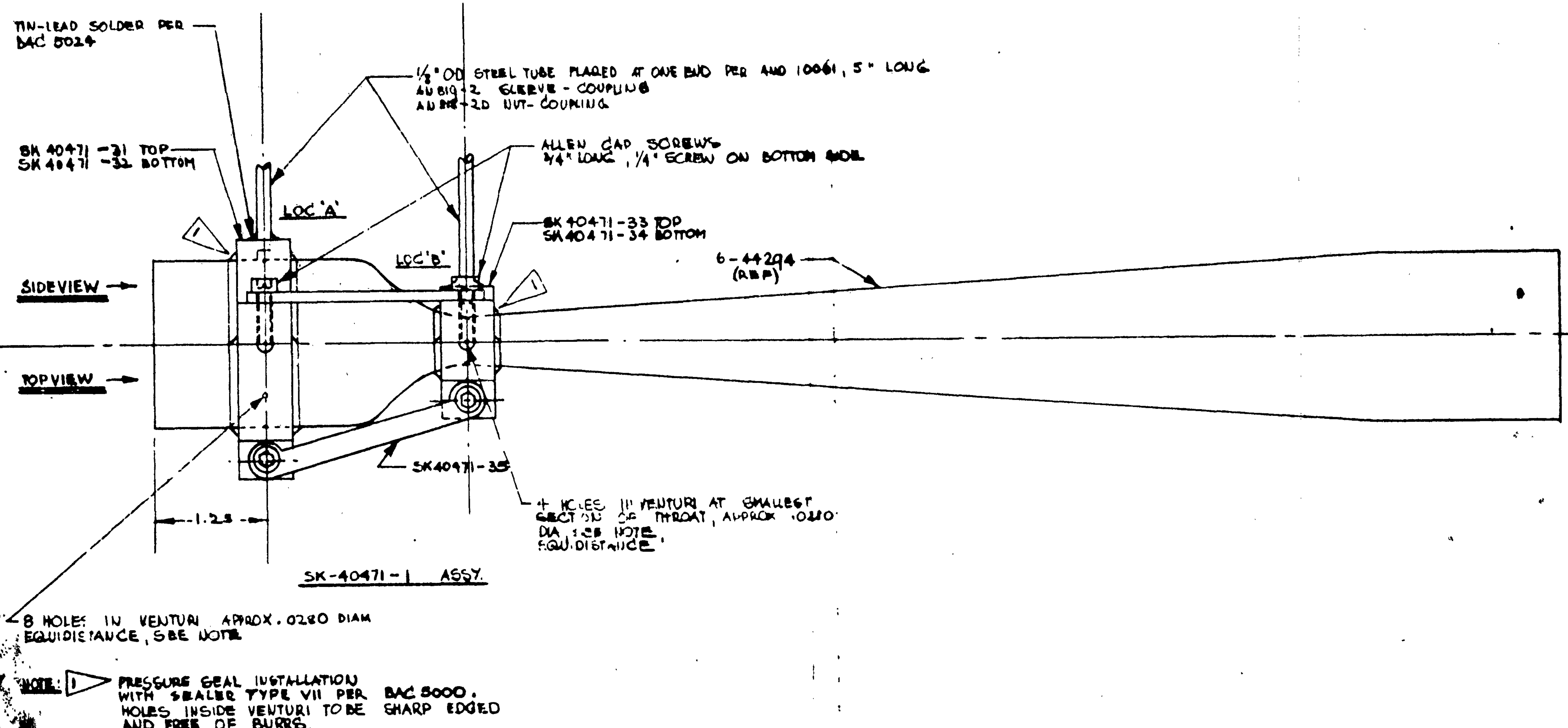
FTW 5533

10-1029-501 BLOWER FOR HUMIDITY MEASUREMENT
Pickup assy. wet and dry bulb temperature per WD-12829 page series 150. See wiring diagrams pages 4.3.6 and 4.3.7 this document.

1 Camera Compartment

2 Nose Compartment

HUMIDITY MEASUREMENTS



1.1.45 Static Pressure Mixed Air Duct to Outside Defrost - Venturi, Location A

SK 40471

1.1.46 Static Pressure Mixed Air Duct to Outside Defrost - Venturi, Location B

			REVISED	DATE
CALC	[illegible]	2-4-54		
CHECK	RCM	4-8-54		
APR	R/B	4/8/54		
APR				
CONTRACT No.				

CAMERA COMPARTMENT AND CABIN DEFROSTING SYSTEM

BOEING AIRPLANE COMPANY
SEATTLE 14, WASHINGTON

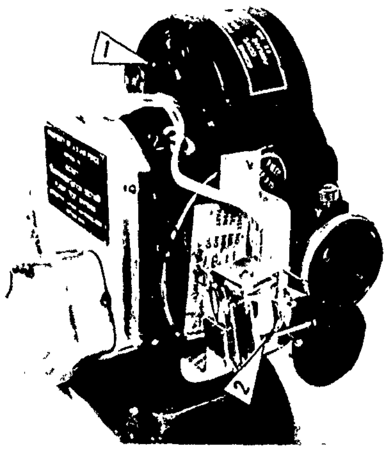
RB-47B 51-5258

WD-13563

PAGE 4.4.83

BAC 1088 R1

6.0 WINDOW CAMERAS (Cont.)



FTW-5593

FILTER ASSY. - A-4 CAMERA

1. Camera Army Type A-4 (AN10-10AA-4)
2. -13 Filter Assembly

SK-40469

CALC	D Krasser	2-3-54	REVISED	DATE	CAMERA COMPARTMENT AND CABIN DEFROSTING SYSTEM
CHECK					
APR		3/15/54			BOEING AIRPLANE COMPANY
APR					WICHITA DIVISION WICHITA 1, KANSAS
CONTRACT NO					INSERT NO I WD-14018 PAGE 34

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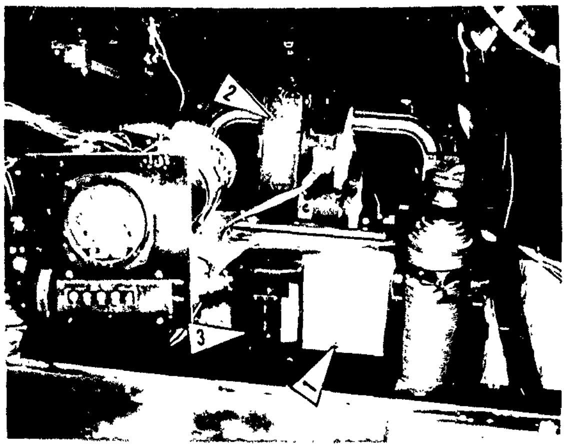
WD-13563

PAGE 4.6.13

6.0 WINDOW CAMERAS (Cont.)



FTW-5520

FWD OBLIQUE & VIEW FINDER WINDOWS (Sta. 80 Approx.)
View - Looking Fwd

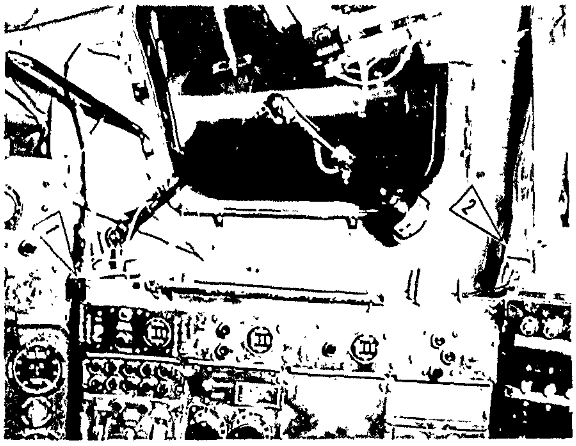
1 - 30 NOSE ASSY.

2 Camera Viewing Fwd. Oblique Window. Position 6 Page 4.3.4

3 Camera Viewing View-Finder Window. Position 7 Page 4.3.4

SK-40469 BW-104122

			REVISED	DATE		
CALC	D Krasser	2-3-59			CAMERA COMPARTMENT AND CABIN DEFROSTING SYSTEM	RB-47E 51-5258
CHECK		2-5-54				
APR		3/15/54			BOEING AIRPLANE COMPANY	WD-13563
APR					WICHITA DIVISION WICHITA 1, KANSAS	
CONTRACT NO.					INSERT NO. 1 WD-14018 PAGE 135	PAGE 4.6.24



(FTW. 5373)

1 NAV. FACE LEVEL, SK-40337 THERMOCOUPLE - ENVIRONMENTAL ATTACH TO STRUCTURE, AT APPROX. STA. 115.6 and WL1425

2 NAV. STATION, SK-40337 THERMOCOUPLE - ENVIRONMENTAL ATTACH TO STRUCTURE AT APPROX. STA. 98.5 and WL144

1.2.16 T-C - Navigator's Station - Face Level
1.2.18 T-C - Navigator's Station

CALC	[illegible]	2-5-54	REVISED	DATE	CAMERA COMPARTMENT AND CABIN AIR CONDITIONING SYSTEM
CHECK	[illegible]	2-11-54			
APR	RJB	3/15/54			BOEING AIRPLANE COMPANY
APR					WICHITA DIVISION WICHITA 1, KANSAS
CONTRACT NO.					INSERT NO 1 WD-14018 PAGE 136

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WD-13563
PAGE 5.4.21

INSERT NO. 2

BOEING AIRPLANE COMPANY

Document WD-13564

TITLE: Flight Test Plans, Conferences and Data - RB-47E, Airplane AF 51-5258

Applicable pages of Plans of Test 5-1, 6-1, and 9-1 only.

Test 5-1 pages 5-1-1 through 5-1-6
Test 6-1 pages 6-1-1 through 6-1-13
Test 9-1 pages 9-1-1 through 9-1-7

Pages 138 to 163

This Plan of Test is applicable to Ground Test 5-3 and 5-4

File

FLIGHT TEST SECTION

PLAN OF TEST

1st PILOT	J. H. Goodell	SCHED. DATE 12-8-53	DAY Tuesday
2nd PILOT		CONFERENCE TIME	
		TAKEOFF TIME	Ground Test Only
G.W. ------	C.G. ------	PLACE:	Wichita, Kansas

GROUND OBSERVERS AND THEIR DUTIES:

L. [illegible] Snediger - Flight Test Engineer
E. [illegible] Louvar - Flight Test Analysis
A. M. Baciak - Flight Test Analysis
E. Nelms - Flight Test Liaison Engineer
W. Murray - Observer MEU (Wibac)
R. Snyder - Observer MEU (Wibac)
J. Creighton - Observer MEU (Wibac)

CONFIGURATION:

In accordance with the airplane General Configuration List for the RB-47E, airplane AF 51-5258, presented in document WD-13400-23, dated December 15, 1953, with the following revisions and items pertinent to this test:

1. Air conditioning system installed in the cabin and camera compartments per Drawings 5-45625 and 5-45626 to simulate the final production configuration of the airplane.

   a. To include a cabin air-moisture separator system per Drawing 5-62616 with an electronic temperature control system to maintain a 35° F. cooling unit discharge temperature, which replaces the pneumatic system on the cabin cooling unit.

   b. With the camera compartment air conditioning system incorporating the 10-819-507 cooling unit and pneumatic control system during Phase I only.

2. Defrosting systems installed in the camera and cabin compartments per Drawings 5-45625 and 5-45626 with the following exceptions and additions:

   a. The 9-43699 water separator by-pass valve modified per Wibac MEU to include an aluminum piston assembly (MEO's 857704 and 900063).

THE CLASSIFICATION OF THIS DATA HAS BEEN CHANGED FROM Confidential TO Unclassified PER [illegible] DATE [illegible] RECIPIENTS OF THIS REVISION ARE RESPONSIBLE FOR CORRECTING OBSOLETE CLASSIFICATIONS THE COVER AND CONTENT PAGES.

PREPARED	12-8-53	AMB E.L.	PLAN Camera Compartment and Cabin Air	MOD. RB-47E
TYPED	12-8-53	JEM	Conditioning and Defrost System	REG. AF 51-5258
CHECKED	12-10-53	LFS JHG	Ground Test TEST NO. 5	WD-13564
APPROVED	12-10-53	AEM	BOEING AIRPLANE COMPANY, SEATTLE 14, WASH.	5-1-1

[redacted]

b. The 110° F. thermal overheat switches, located adjacent to the blowers in the camera compartment, removed from the system at the time the cooling unit in the camera compartment is made inoperative for Phase II.

3. All electronic and electrical equipment normally installed in these compartments installed and operable.

4. Instrumentation to remotely record all pertinent temperatures, pressures, and other data requested on outlines for Flight Test, Reference Nos, 0-708 and 0-709 Rev. A.

TEST: Contract AF33(600)-5148 (708, 709)

Purposes: (1) To verify the cabin leakage rate and to check the cabin depressurization system prior to flight test.

(2) To functionally test the operation and adequacy of the following specific installations:

(a) The electronic temperature control system versus the pneumatic temperature control system for the cabin and camera compartment cooling units.

(b) Defrosting air temperature control system (crew and camera compartments).

(c) Defrosting air distribution system (crew and camera compartments).

(d) Camera ventilation system (crew compartment only).

(e) NESA window for camera control units (Section 43 compartment).

1. Cabin Depressurization

With the bomb bay doors closed, main entrance door closed, and radome cover attached, pressurize the cabin to 6.55 psi above ambient pressure. Depressurize the cabin by pulling the cabin pressure release handle.

DATA: (1) OAT, barometric pressure, cabin pressure, cabin temperature and counter number.

(2) Photorecorder ON 5/1, Brown recorder ON.

2. Functional Test - Cabin Leakage

Check cabin pressure and leakage rate per D-9700, Section 06.0101, and record.

DATA: (1) OAT, barometric pressure, cabin pressure, cabin temperature and counter number.

(2) A record of the leakage rate which is to be included with the ground and flight test data.

3. Functional Test - Cabin Air Conditioning System

Prior to recording any ground run data, thoroughly check the function of the cabin cooling unit electronic temperature control system and the camera compartment cooling unit pneumatic temperature control system per EEO 070804 and EEO 070805, Revisions to D-9700.

While operating Engines 1, 2, and 3, record the cabin air conditioning system data during the following stabilized conditions:

Condition	Power Setting
a	65% RPM for 5 minutes
b	90% RPM for 5 minutes
c	75% RPM for 5 minutes
d	50% RPM for 5 minutes

DATA: (1) Coordination counter number.

(2) Barometric pressure and dew point.

(3) Photorecorder on 1 per 10.

(4) Brown recorder ON.

(5) Oscillograph ON.

(6) Amount of flow of water from the air-moisture separator drain line.

4. Functional Test - Camera Compartment Air Conditioning System - Part I

While operating Engines 4, 5, and 6, record the cabin air conditioning system data during the following stabilized conditions:

Condition	Power Setting
a	65% RPM for 5 minutes
b	90% RPM for 5 minutes
c	75% RPM for 5 minutes
d	50% RPM for 5 minutes

DATA: (1) Coordination counter numbers.

(2) Barometric pressure, OAT, and dew point.

(3) Photorecorder on 1 per 10.

(4) Brown recorder ON.

(5) Oscillograph ON.

5. Functional Test - Camera Compartment Air Conditioning System - Part II

With the air conditioning system operating, operate Engines 4, 5, and 6 at 80% RPM with (1) configuration of the 10-819-4 aneroid switch normal, (2) the electrical plug removed from that aneroid switch and a jumper wire installed between pins "A" and "B" on the plug, and (3) the jumper removed and the plug replaced on the aneroid switch. Transition between conditions is to be rapid.

Condition	Requirements
a	Run at 80% RPM for 5 minutes.
b	Run at 80% RPM for 5 minutes with jumper across pins of plug.
c	Run at 80% RPM for 5 minutes with jumper removed and the plug re-installed.

DATA: (1) Coordination counter numbers.

(2) Barometric pressure, OAT, and dew point.

(3) Photorecorder on 1 per 10.

(4) Brown recorder ON.

(5) Oscillograph ON.

6. Functional Test - Camera and Cabin Compartment Defrosting Systems

After completion of necessary instrumentation, and prior to any testing, the defrosting systems and the camera accessories compartment MESA panel shall have been functionally tested in accordance with applicable sections of D-9700.

With the openings to the wheel well area and crew entrance hatch open, operate the engines necessary to obtain the required engine bleed pressures as constant as possible throughout the following conditions:

[redacted]

Condition	Engines To Be Run	Engine Bleed Pressure	Operators	Observers
a	3 and 4	25-30 psi (pressure taps No. 1 and 46)	Start engines and adjust RPM to as necessary to establish engine bleed pressures required. Energize both defrost systems.	Record time for stabilization of mixed air temperature (thermocouple No. 9 and 55). Check for reverse flow in blowers by observation. Check inlet air temperature to one blower (thermocouple No. 3).
b	3 and 4	60 psi or max. obtainable (pressure taps No. 1 and 46)	With conditions the same as above, increase the power as necessary and hold for 15 minutes.	Check effect of transient engine power changes on both defrost systems and stabilization of mixed air as above.
c	4	As above (pressure tap No. 1)	Shut off cabin compartment defrost system. De-energize both blowers in camera compartment (pull circuit breakers 06-35 on Panel J110, or remove the ground relay R8 on Panel J110, camera power distribution panel, or remove power leads to both blowers simultaneously, or power lead H414F20).	Check effect of blower failure on camera compartment defrost system, reverse flow through blowers, time required for overheat to occur, and which overheat device actuated.
d	4	25-30 psi	Reduce power and stabilize while modulation valve position is recorded by observer. Remove power lead at the modulation valve.	Record stabilized modulation valve position in degrees open.

CALC			Camera Compartment and Cabin Air Conditioning and Defrost System Ground Test	RB-47E AF51-5258
CHECK				
APR				D-13564
APR			BOEING AIRPLANE COMPANY, WICHITA, KANSAS	5-1-5

[redacted]

Condition	Engines To Be Run	Engine Bleed Pressure	Operators	Observers
e	4	Increase to 60 psi or maximum obtainable	Increase engine power.	Check for reverse flow through blowers by observation and record time for an overheat to occur (time for actuation of defrost failure light L4 on J72 camera compartment air conditioning panel), and which overheat device actuated (time-temperature recording of air temperature near duct overheat thermal switch-thermocouple No. 9).

DATA: Ground Observer - (1) Brown recorder ON.

(2) Photorecorder on 1 per 1.

(3) Oscillograph ON.

(4) A-4 cameras on 1 per 1.

Checked by *Louis F. Lindquist*
Flight Operations Engineer

Checked by *J. H. Goodell*
Flight Test Project Pilot

Approved by *R. E. Merrill*
Chief of Flight Test

CALC			Camera Compartment and Cabin Air Conditioning and Defrost System Ground Test	RB-47E AF51-5258
CHECK				
APR				WD-13564
APR			BOEING AIRPLANE COMPANY, WICHITA, KANSAS	5-1-6

This Plan of Test applicable to Navigator's Compartment Defrost System Checkout Test 6.1 as Noted.

File

FLIGHT TEST SECTION

PLAN OF TEST

1st PILOT J. Goodell	SCHED. DATE 2-3-54	DAY Wednesday	
2nd PILOT C. R. Graffy	CONFERENCE TIME		
NAVIGATOR G. Simons	TAKEOFF TIME		
G.W. 147,000 Lbs. C.G. 18% MAC W.D.*	PLACE: Wichita, Kansas		

* Approximate

THE CLASSIFICATION OF THIS DATA HAS BEEN CHANGED FR Confid'l TO Unclass'd PER [illegible] DATE 4-26-[illegible]
RECIPIENTS OF THIS REVISION ARE RESPONSIBLE
*FOR CORRECTING OBSOLETE CLASSIFICATIONS ON
THE COVER AND CONTENT PAGES.

CONFIGURATION:

In accordance with the airplane General Configuration List for the RB-47E, airplane AF 51-5258, presented in Document WD-13400-23, dated December 15, 1953, with the following revisions and items pertinent to these tests:

1. Air conditioning systems installed in the cabin and camera compartments per Drawings 5-45625 and 5-45626 to simulate the latest production configuration of the airplane.

   a. To include a cabin air-moisture separator per Drawing 5-62616 with an electronic temperature control system to maintain a 35° F. cooling unit discharge temperature, which replaces the pneumatic temperature control system on the cabin cooling unit.

   b. A modified anti-icing by-pass valve, S/N 13-168, actuator S/N 13-173, on the cabin air conditioning system cooling unit with a full open position of 30° replacing the original 10-1078-7 valve with a full open position of 47.5° per EEO 070807.

   c. With the camera compartment air conditioning system incorporating the 10-819-507 cooling unit and pneumatic control system.

2. All electrical and electronic equipment normally installed in these compartments installed and operable with the following exceptions:

   a. Hand control antenna, indicator control, and control box removed from the A-5 fire control system aft of the co-pilot's station.

   b. Electrical heating elements, encased strip type, mounted in the camera compartment to simulate the heat output of the universal camera control system.

      (1) 3,000 watts approximately evenly distributed across the electrical equipment shelf of the rear of the compartment.

PREPARED	1-29-54	EJL	PLAN Camera Compartment and Cabin Air	MOD RB-47E
TYPED	2--2-54	JTM	Conditioning Test (Phase I), and Miscel-	REG. AF 51-5258
CHECKED	2--2-54	LFS JHG	laneous Test Items TEST NO. 6	WD-13564
APPROVED	2--2-54	AEM	BOEING AIRPLANE COMPANY, SEATTLE 14, WASH.	6-1-1

Rev. 2-2-54 LFS

[redacted]

[redacted]

(2) 500 watts at the vertical camera station.

(3) 250 watts at the split-vertical camera station.

(4) 250 watts at the tri-camera station.

3. Standard photo-reconnaissance cameras removed and the following test cameras installed to photograph any frost on the camera windows.

   a. Four A-4 cameras in the camera compartment, one each for the windows at the vertical station, split-vertical station, L.H. light detector, and two of the windows at the tri-met station.

   b. One A-4 camera in the tail compartment (NESA panel).

   c. One A-4 camera for the forward oblique station and nose windows. 1

   d. One GSAP camera (16mm) for the viewfinder window. 1

   e. One cine'-special (16mm hand held) camera for navigator or observer. 1

4. Instrumentation to record data requested on Outline for Flight Test, Reference 0-708.

   a. Brown recorder to record all pertinent temperatures except wet-bulb readings.

   b. Photorecorder to record all pertinent pressures.

   c. Oscillograph to record the dry-bulb and wet-bulb temperatures.

5. Revised air inlet to alternator on Engine No. 1, consisting of a revised outboard accessory dome utilizing a baffled nose-cone plenum chamber with a flanged right angle air inlet adapter installed per WFT-724, EEO 275868.

6. Interphone-microphone switch on pilot's and co-pilot's control wheels modified per ECP 2125M to reduce the switch pre-travel.

__TEST:__ Contract AF33(600)-5148 (708, 724, 671, 776)

__Purposes:__ (1) To accomplish an airplane checkout.

(2) To verify the reliability and operational characteristics of the RB-47E camera compartment air conditioning system.

(3) To verify the reliability and operational characteristics of the portions of the RB-47E cabin air conditioning system which are different from the B-47E system.

(4) To functionally test the operation and adequacy of the electronic temperature control system versus the pneumatic temperature control system for the cabin and compartment cooling units.

(5) To determine if the inlet air moisture separator for the 20 KVA alternator will reduce the moisture in the cooling air sufficiently to eliminate fluctuating output AC voltage and/or reversal of alternator exciter polarity when operating in a moisture-laden atmosphere.

(6) To determine if existing drain seals and/or drains are adequate to prevent harmful quantities of water from entering or collecting in various airplane compartments.

(7) To determine whether interphone-microphone switch modifications have reduced the force requirement for actuation of the switch to the point where the installation is satisfactory.

1. Airplane and Instrumentation Checkout

An airplane checkout to the pilot's satisfaction shall be accomplished and shall include the items listed below. The electrical heating elements shall not be installed in the camera compartment for this checkout flight only.

a. Trim coordination check.

b. Cabin pressurization check.

c. Cabin depressurization check.

d. NESA windshield defrost system check.

e. With the cabin camera compartment air conditioning systems ON, perform the following conditions:

(1) Stabilized straight and level flight for 30 seconds with both Brown recorders ON (cycling on all banks), the oscillograph ON, and during this 30 seconds both photorecorders shall be operated for 15 seconds at 1 per 1, and 5 per 1.

(2). A 5,000-foot descent or climb while operating both Brown recorders (cycling on all banks), oscillograph, and the photorecorders on 1 per 1.

f. With the cabin and camera compartments defrosting systems ON, perform the conditions listed in "e" above.

DATA: Pilot - (1) Altitude, IAS, counter numbers.

(2) Pertinent comments.

Co-Pilot - (1) Operate the instrumentation as outlined above.

(2) Comments.

Navigator - (1) Operate the systems as outlined above.

(2) Comments.

General Notes for all Air Conditioning Test Items

Prior to this flight test, the airplane shall be completely functionally tested per applicable sections of D-9700, "Functional Test Requirements and Procedures, Model B-47" and also in accordance with Plan of Test 5-1 for the pertinent ground tests.

In order to obtain a heat balance for this test it will be necessary to turn on the radio when first entering the airplane and report the turning on or off of any electrical equipment and at what counter number.

Since it is necessary to conduct the entire air conditioning test in the sequence listed and since all test conditions must be completed in order to simulate a mission, the following switch, control, and selector positions, and other pertinent designations apply to all the conditions of the air conditioning test, except when noted otherwise:

a. Both the cabin and camera compartment master switches ON.

b. The cabin and camera compartment defrosting systems operating. 1

c. The cabin and camera compartment temperature controls each set in the AUTO position (in the region of 60° F. to 70° F. selection for the cabin compartment).

d. The navigator's manual control valve for nose defrosting in the ON position. 1

e. The cabin pressurization selection on COMPRESSED AIR.

f. The weaponeer's crew station outlet to BOTH OFF.

g. Other crew station outlets at the same selection as selected by the pilot.

h. The heat distribution mixing box handle in the maximum position to increase the temperature of the lower outlets.

i. The RPM on all engines maintained within one percent of one another.

2. Normal Rated Climb to Approximately 40,000 Feet Altitude

With selections as specified in the general notes, and with all camera doors closed, make a normal rated climb to maximum range cruise altitude (approximately 40,000 feet).

DATA: Pilot - (1) Prior to starting the climb, report cloud coverage and degree of sun penetration.

(2) Airplane altitude, IAS, cabin altitude, OAT, % RPM, and coordination counter numbers at 5,000-foot altitude increments.

(3) Electrical or electronic equipment operation.

(4) Observation of and comments on:

(a) Issuance of moisture forms from cabin air outlets during operation of the cabin water separator, particularly during changes of engine RPM.

(b) Frosting or fogging of the canopy and coordination number at occurrence.

(c) Indications of instability of cabin pressure or temperature.

(d) Any other objectionable features of the cabin air conditioning system.

Co-Pilot - (1) Right and left-hand photorecorder on 1 per 10; Brown recorder ON (stepping Switch 1, Bank A and stepping Switch 4, Bank B); oscillograph ON.

(2) Calibrate the oscillograph every 10 minutes for 3 seconds.

(3) Electrical or electronic equipment operation.

(4) Observation of and comments on:

(a) Issuance of moisture forms from cabin air outlets during operation of the cabin water separator, particularly during changes of engine RPM.

(b) Frosting or fogging of the canopy and coordination number at occurrence.

(c) Any other objectionable features of the cabin air conditioning system.

Navigator - (1) Monitor the camera compartment temperature.

(2) Electrical or electronic equipment operation.

(3) Observation of and comments on:

(a) Issuance of moisture forms from the cabin air outlets during operation of the water separator, particularly during changes of engine RPM.

(b) Any other objectionable features of the cabin air conditioning system.

3. Simulation of No Camera Compartment Air Conditioning Unit at Maximum Range Cruise Condition

With selections as specified in the General Notes, and with all camera doors closed, establish a maximum range cruise flight condition of altitude and Mach .75. After a one-hour cold-soak period, turn on the electrical heater elements in the compartment. After two minutes, turn off the camera compartment master switch, but leave the compartment defrost on. Fly with this configuration until the heater elements have been on for 30 minutes, unless the compartment temperature exceeds 165° F., in which event the heaters are to be turned off and the compartment cooled immediately. If the compartment temperature does not exceed 165° F., after the 30 minutes have expired, turn on the camera compartment master switch and the heating elements off.

DATA: Pilot - (1) Airplane altitude, IAS, compartment temperature, OAT, % RPM, and coordination counter numbers every 5 minutes.

(2) Electrical or electronic equipment operation.

(3) Observation and comments as in Item 2, data, Paragraph 4.

Co-Pilot - (1) Right-hand photorecorder OFF; left-hand photorecorder on 1 per 10 except 1 per 1 during the period from immediately before the air conditioning system is turned off until 10 minutes thereafter; Brown recorder ON; oscillograph ON during the first 10 minutes of the cold-soak period, OFF during the rest of the condition.

(2) Calibrate the oscillograph for 3 seconds just before turning it off.

(3) Electrical or electronic equipment operation.

(4) Observation and comments as in Item 2, data, Paragraph 4.

[redacted]

Navigator - (1) Monitor the camera compartment temperatures.

(2) Electrical or electronic equipment operation.

(3) Observation and comments as in Item 2, data, Paragraph 3.

4. Flight at Maximum Range Cruise Altitude (Approximately 40,000 Feet)

With selections as specified in the General Notes, open the camera compartment camera doors and establish a maximum range cruise flight condition of altitude and Mach .75 until compartment conditions are stabilized (minimum of 30 minutes).

DATA: Pilot - (1) At the start, middle, and end of condition, report cloud coverage and degree of sun penetration.

(2) Airplane altitude, IAS, cabin altitude, cabin temperature, OAT, % RPM and coordination counter numbers every 5 minutes.

(3) Electrical or electronic equipment operation.

(4) Observation and comments as in Item 2, data, Paragraph 4.

Co-Pilot - (1) Right-hand photorecorder on 1 per 10; left-hand photorecorder on 1 per 10 during first 25 minutes of stabilization, then 1 per 1 during the last 5 minutes; Brown recorder ON; and oscillograph ON.

(2) Calibrate oscillograph every 10 minutes for 3 seconds.

(3) Electrical or electronic equipment operation.

(4) Observation and comments as in Item 2, data, Paragraph 4.

Navigator - (1) Temperature readings from the camera compartment, TC 22, and TC 69 every 60 seconds.

(2) Electrical or electronic equipment operation.

(3) Counter number when camera doors are opened.

(4) Observation and comments as in Item 2, data, Paragraph 3.

[redacted]

5. Maximum Rated Descent From 40,000 Feet Altitude

With selections as specified in the General Notes except RPM (see below), close the camera compartment camera doors and make a maximum rated descent from 40,000 feet to approximately 1,000 feet above the surrounding terrain. Engines are to be held at approximately idle power except as necessary to avoid low frequency warnings from the alternators on Engines No. 1 and No. 6.

DATA: Pilot - (1) Prior to starting and after completing the descent, report cloud coverage and degree of sun penetration.

(2) Airplane altitude, IAS, cabin altitude, cabin temperature, OAT, % RPM, coordination counter numbers at 5,000-foot altitude decrements.

(3) Electrical or electronic equipment operation.

(4) Observation and comments as in Item 2, data, Paragraph 4.

Co-Pilot - (1) Right-hand photorecorder on 1 per 1; left-hand photorecorder on 1 per 10; Brown recorder ON; oscillograph ON.

(2) Observation and comments as in Item 2, data, Paragraph 4.

Navigator - (1) Monitor the camera compartment temperature.

(2) Electrical or electronic equipment operation.

(3) Counter number when doors are closed.

(4) Observation and comments as in Item 2, data, Paragraph 3.

6. Level Flight at Low Altitude

With selections as specified in the General Notes, open the camera compartment camera doors and perform level flight at approximately 1,000 feet above the surrounding terrain at the allowable maximum RPM and also at the allowable minimum RPM.

Condition	Requirement	Gear Position	Flap Position
a	Maximum RPM for 10 minutes	Down	Up
b	Minimum RPM for 10 minutes	Up	Down*

* Pilot's option on flap position.

CALC			Camera Compartment and Cabin Air Conditioning Test (Phase I), and Miscellaneous Test Items	RB-47E AF51-5258
CHECK				
APR				D-13564
APR			BOEING AIRPLANE COMPANY, SEATTLE 14, WASH.	6-1-8

[redacted]

DATA: Pilot - (1) At the end of the condition, report cloud coverage and degree of sun penetration.

(2) Airplane altitude, IAS, OAT, % RPM, coordination counter numbers once a minute during each speed run.

(3) Electrical or electronic equipment operation.

(4) Observation and comments as in Item 2, data, Paragraph 4.

Co-Pilot - (1) Right-hand photorecorder on 1 per 1; left-hand photorecorder on 1 per 10 for the first 7 minutes of each condition and on 1 per 1 during the last 3 minutes of each; Brown recorder ON; oscillograph ON.

(2) Calibrate oscillograph every 10 minutes for 3 seconds.

(3) Electrical or electronic equipment operation.

(4) Observation and comments as in Item 2, data, Paragraph 4.

Navigator - (1) Monitor the camera compartment temperature.

(2) Electrical or electronic equipment operation.

(3) Counter number when doors are opened.

(4) Observation and comments as in Item 2, data, Paragraph 3.

7. Normal Rated Climb to 15,000 Feet Altitude

With selections as specified in the General Notes, close the camera compartment camera doors and make a normal rated climb to 15,000 feet.

DATA: Pilot - (1) At the end of the condition, report cloud coverage and degree of sun penetration.

(2) Airplane altitude, IAS, OAT, % RPM, and coordination counter numbers at 5,000-foot altitude increments.

(3) Electrical or electronic equipment operation.

(4) Observations and comments as in Item 2, data, Paragraph 4.

Co-Pilot - (1) Right-hand photorecorder on 1 per 1; left-hand photorecorder on 1 per 10; Brown recorder ON; oscillograph ON.

(2) Electrical or electronic equipment operation.

(3) Observation and comments as in Item 2, data, Paragraph 4.

Navigator - (1) Monitor the camera compartment temperature.

(2) Electrical or electronic equipment operation.

(3) Observations and comments as in Item 2, data, Paragraph 3.

(4) Counter number when the doors are closed.

8. Level Flight at 15,000 Feet Altitude

With selections as specified in the General Notes, open the camera compartment camera doors and perform level flight to accomplish the following conditions:

Condition	Requirement
a	Level flight at intermediate RPM for 10 minutes.
b	Level flight at maximum RPM for 10 minutes.
c	Level flight at minimum RPM for 10 minutes.

DATA: Pilot - (1) During Condition b and at the end of Condition c, report cloud coverage and degree of sun penetration.

(2) Airplane altitude, IAS, cabin altitude, cabin temperature, OAT, % RPM, coordination counter numbers three times during each condition.

(3) Electrical or electronic equipment operation.

(4) Observation and comments as in Item 2, data, Paragraph 4.

Co-Pilot - (1) Right-hand photorecorder on 1 per 1; left-hand photorecorder on 1 per 10 during first 7 minutes of each RPM run, and on 1 per 1 during the last 3 minutes of each; Brown recorder ON; oscillograph ON.

(2) Calibrate the oscillograph every 10 minutes for 3 seconds.

(3) Electrical or electronic equipment operation.

(4) Observation and comments as in Item 2, data, Paragraph 4.

Navigator - (1) Monitor the camera compartment temperature.

(2) Electrical or electronic equipment operation.

(3) Counter number when doors are opened.

(4) Observation and comments as in Item 2, data, Paragraph 3.

9. Maximum Rated Descent from 15,000 Feet Altitude and Immediate Landing

With selections as specified in the General Notes, except RPM (see below), close the camera compartment camera doors and make a maximum rated descent from 15,000 feet altitude to traffic altitude and land as soon as possible after the pull-out. Engines are to be held at approximately idle power except as necessary to avoid low frequency warnings from the alternators on Engines No. 1 and No. 6.

DATA: Pilot - (1) After the pull-out, report cloud coverage and degree of sun penetration.

(2) Airplane altitude, IAS, cabin altitude, OAT, % RPM, and coordination counter numbers at 5,000-foot altitude decrements.

(3) Electrical or electronic equipment operation.

(4) Observation and comments as in Item 2, data, Paragraph 4.

Co-Pilot - (1) Right and left-hand photorecorder on 1 per 10; Brown recorder ON; oscillograph ON.

(2) Calibrate the oscillograph after the pull-out and after the landing for 3 seconds.

(3) Electrical or electronic equipment operation.

(4) Observation and comments as in Item 2, data, Paragraph 4.

Navigator - (1) Monitor the camera compartment temperature.

(2) Electrical or electronic equipment operation.

(3) Counter number when camera doors are closed.

(4) Observation and comments as in Item 2, data, Paragraph 3.

[redacted]

10. <u>Alternator Air Inlet Water Separator Test</u>

In order to evaluate the alternator water separator installed on Engine No. 1 fly the airplane through rain as heavy as safety of flight will permit, varying the airplane speed within safe limits.

Condition	Requirement
a	Flight at lower safe speed limit.
b	Flight at upper safe speed limit.

<u>DATA</u>: <u>Pilot</u> - (1) Intensity, duration and time of rainfall.

<u>Co-Pilot</u> - (1) Oscillograph ON.

(2) Unusual operation or malfunction of either alternator, and time of occurrence.

11. <u>Raintightness</u>

The raintightness of the RB-47E airplane shall be investigated during flight operation: Fly the airplane in a heavy rain with the crew compartment unpressurized for a sufficient length of time (Maximum 30 minutes) to thoroughly check for water tightness.

<u>NOTE</u>: Immediately after landing inspect the airplane for leakage and trapped water, using procedure as called for in the ground test conditions (Paragraph B of the outline of the test).

Particular note should be made of any cases where the leakage found may adversely affect the service life of any part of the airplane or its components.

<u>DATA</u>: <u>Pilot</u> - (1) General comments on raintightness.

(2) Time of flight in rain.

(3) IAS, altitude, and OAT.

<u>Co-Pilot</u> - (1) General comments on raintightness.

<u>Navigator</u> - (1) General comments on raintightness of the escape hatch and nose canopy.

<u>Technical Observer (Ground)</u> - (1) Amount and location of trapped water.

(2) General comments on raintightness.

12. Interphone-Microphone Switch Operation

Evaluate the switch operation during normal flight operation.

DATA: Pilot - (1) Switch actuating force (whether there is any decrease over the previous production configuration in the required effort).

(2) Desirability of knurling on button.

(3) Effect on glove wear and thumb fatigue.

Co-Pilot - (1) Same as for the pilot.

Checked by Louis F. Snedeger Jr.
Flight Operations Engineer

Checked by J. H. Goodell
Flight Test Project Pilot

Approved by A. E. Merrill
Chief of Flight Test

This Plan of Test is applicable to Tests 9-1 through 9-4 inclusive

FLIGHT TEST SECTION

PLAN OF TEST

1st PILOT J. Goodall	SCHED. DATE 3-5-54	DAY Friday	
2nd PILOT C. Graffy	CONFERENCE TIME		
NAVIGATOR: G. Simons	TAKEOFF TIME		
G.W. 150,000 Lbs.	C.G. 25% MAC - W.D.	PLACE: Wichita, Kansas	

CONFIGURATION:

In accordance with the airplane General Configuration List for the RB-47E, airplane AF 51-5258, presented in Document WD-13400-23, dated December 15, 1953, with the following revisions and items pertinent to these tests:

1. Air conditioning systems and defrost systems installed in the cabin and camera compartments per Drawings 5-45625 and 5-45626 to simulate the latest production configuration of the airplane.

   a. To include a cabin air-moisture separator per Drawing 5-62616 with an electronic temperature control system to maintain a 35° F. cooling unit discharge temperature, which replaces the pneumatic temperature control system on the cabin cooling unit.

   b. The camera compartment cooling unit operative and the camera compartment temperature selector adjusted to maintain a compartment temperature of 70° F. ±10°.

All electrical and electronic equipment normally installed in these compartments installed and operable with the following exception:

Standard photo-reconnaissance cameras removed and the following test cameras installed to photograph any frost on the camera windows.

a. Four A-4 cameras in the camera compartment, one each for the windows at the vertical station, split-vertical station, L.H. light detector, and two of the windows at the tri-met station.

b. One A-4 camera in the tail compartment (NESA panel).

c. One A-4 camera for the forward oblique station and nose windows.

d. One GSAP camera (16mm) for the viewfinder window.

e. One cine-special (16mm hand held) camera for navigator or observer.

THE CLASSIFICATION OF THIS DATA HAS BEEN CHANGED FROM Confidential TO Unclassified PER memo SPAL DATE 4-26-55 RECIPIENTS OF THIS REVISION ARE RESPONSIBLE FOR CORRECTING OBSOLETE CLASSIFICATIONS ON THE COVER AND CONTENT PAGES

PREPARED	3-3-54	AMB	PLAN Camera Compartment and Cabin	MOD. RB-47E
TYPED	3-4-54	WIK	Defrosting, Alternator Water Separator,	REG. AF 51-5258
CHECKED	3-5-54	LPS JMG	and Raintightness Test TEST NO. 9	WD-13564
APPROVED	3-5-54	HWT	BOEING AIRPLANE COMPANY, SEATTLE 14, WASH.	9-1-1

Electrical heating elements, encased strip type, mounted in the camera compartment to simulate the heat output of the universal camera control system.

a. 500 watts at the vertical camera station.

b. 250 watts at the split-vertical camera station.

c. 250 watts at the tri-camera station.

3. Instrumentation to record data requested on Outline for Flight Test, Reference 0-709, Rev. A.

   a. Brown recorders to record all pertinent temperatures except humidity readings.

   b. Photorecorder to record all pertinent pressures.

   c. Oscillograph to record humidity temperatures.

<u>TEST:</u> Contract AF33(600)-5148 (709, 671)

<u>Purposes:</u> (1) To verify the adequacy and operational characteristics of the following specific installations on the RB-47E.

(a) Defrosting air temperature control system (crew and camera compartments).

(b) Defrosting air distribution system (crew and camera compartments).

(c) Camera ventilation systems (crew compartment only).

(d) NESA window for camera control units (Section 43 compartment).

(2) To determine if existing drain seals and/or drains are adequate to prevent harmful quantities of water from entering or collecting in various airplane compartments.

<u>General Comments - Crew and Camera Compartment Defrost System</u>

Since it is necessary to conduct the defrosting test in the order listed, and since all of the following test conditions must be completed in order to simulate a mission, the following comments are pertinent to the entire flight:

(a) Prior to flight test, the defrosting systems and the camera accessories NESA panel shall be functionally tested per applicable sections of D-9700, and per Ground Tests 5-4 and 5-6.

(b) The defrosting system should be flight tested on days when high dew point temperatures are encountered.

(c) Atomspheric dew point data for various altitudes, at approximately the same time as the test is to be performed, will be obtained from the U.S. Weather Bureau at Wichita, Kansas by the ground observer.

(d) A normal cabin pressure schedule will be maintained throughout the test.

(e) The cabin temperature control should be set on automatic and at approximately 60 degrees to 70 degrees Fahrenheit.

(f) Both weaponeers air outlets should be turned off and all other crew selector knobs set in the same position as that selected by the pilot.

(g) During the entire flight, both defrost systems, camera accessories NESA panel, Brown recorders, and intervalometer will be turned on.

(h) The observer will be prepared to photograph any frost or fogging of the navigator's side windows with a cine special camera.

1. Normal Rated Climb to Approximately 40,000 Feet Altitude

With the configuration listed under "General Comments" and with the camera window cover doors and the viewfinder door closed, make a normal takeoff and a normal rated climb to the altitude required to establish a maximum range cruise condition.

DATA: Pilot - (1) Altitude, IAS, OAT, % RPM, and counter number at 5,000-foot increments of altitude.

(2) Comments pertinent to defrosting.

Co-Pilot - (1) Brown recorders ON.

(2) Oscillograph ON.

(3) Right and left-hand photorecorders ON 1 frame per 10 seconds.

Navigator - (1) Camera compartment temperature at 5,000-foot increments of altitude.

(2) Counter number when defrost system is turned ON.

2. Level Flight at Approximately 40,000 Feet Altitude

With the configuration listed under "General Comments", establish a maximum range cruise condition (88% RPM, approximately .74 Mach), and maintain for 2.5 hours. The RPM on all engines should be maintained within one percent of one another.

CALC			Camera Compartment and Cabin Defrosting, Alternator Water Separator, and Raintightness Test	RB-47E AF51-5258
CHECK				
APR				WD-13564
APR			BOEING AIRPLANE COMPANY, SEATTLE 14, WASH.	9-1-3

One hour after starting this condition, the observer will open the camera window cover doors and the viewfinder door for a period of 25 minutes. After the 25-minute period the doors will be closed for the remaining period of one hour and five minutes. The electrical heating elements in the camera compartment will be turned ON 5 minutes before opening the camera window cover doors and viewfinder door and remain ON for a period of 30 minutes.

DATA: Pilot - (1) Altitude, IAS, % RPM, OAT, and counter number every 10 minutes.

(2) General comments on defrosting.

Co-Pilot - (1) Both Brown recorders ON.

(2) Oscillograph turned OFF 5 minutes after leveling off, ON just prior to opening the camera doors, OFF 5 minutes after the camera doors are closed, and ON 5 minutes before descent.

(3) Right-hand photorecorder ON one frame per 10 seconds after leveling off, one frame per second when the camera doors are opened until 5 minutes after the doors are closed, one frame per 10 seconds until 5 minutes before descent, and then one frame per second.

(4) Left-hand photorecorder ON one frame per 10 seconds.

Navigator - (1) Camera compartment temperature.

(2) Time-temperature history of Thermocouples No. 22 and No. 69 every 100 counter numbers until steady state is reached during the period after level off at cruise altitude and after the camera window cover doors and viewfinder door are closed.

(3) A-4 cameras ON one frame per 10 seconds during the period the camera doors are opened until 5 minutes after the doors are closed. Five minutes before letdown, turn the A-4 cameras ON one frame per 10 seconds.

(4) Counter number when doors are opened and closed and when heat load is turned ON or OFF.

(5) General comments on the defrost system.

3. Maximum Rate Descent to 1,000 Feet Altitude

With the configurations listed under "General Comments", the camera window cover doors and the viewfinder door closed, and the RPM of all engines

maintained within one percent of one another, make a maximum rate descent to 1,000 feet above the surrounding terrain.

DATA: Pilot - (1) Altitude, IAS, OAT, % RPM, and counter number at start of descent and 5,000-foot increments of altitude.

(2) Comments pertinent to defrosting.

Co-Pilot - (1) Brown recorders ON.

(2) Oscillograph ON.

(3) Right-hand photorecorder ON one frame per second.

(4) Left-hand photorecorder ON one frame per 10 seconds.

Navigator - (1) Record counter number at start of descent.

(2) A-4 cameras ON one frame per 10 seconds.

(3) Camera compartment temperature at 5,000-foot increments of altitude.

(4) Electrical heating elements turned ON at approximately 5,000 feet altitude.

(5) Counter number when heating elements are turned ON.

(6) General comments on defrost system.

4. Maximum Speed Dash Conditions at 1,000 Feet Above Surrounding Terrain

At 1,000 feet above the surrounding terrain and with the configurations previously listed under "General Comments", open the camera window cover doors and the viewfinder door and establish maximum allowable speed for 15 minutes. Upon completion of the 15-minute period, close the camera window cover doors and the viewfinder door and maintain the maximum allowable speed an additional 10 minutes.

NOTE: The engine bleed pressure should be held as constant as possible throughout this test.

DATA: Pilot - (1) Altitude, IAS, OAT, % RPM, position, true heading, and counter number at the beginning and the end of the speed run.

(2) Comments pertinent to defrosting.

Co-Pilot - (1) Right-hand photorecorder ON one frame per second.

(2) Brown recorders ON.

(3) Oscillograph ON.

(4) After the maximum allowable speed conditions (or 25 minutes after leveling off) at 1,000 feet altitude, turn the right-hand photorecorder to one frame per 10 seconds and the oscillograph OFF.

(5) Left-hand photorecorder ON one frame per 10 seconds.

Navigator - (1) Immediately upon leveling OFF open the camera window cover doors and the viewfinder door for a period of 15 minutes.

(2) After the 15-minute open period, close doors. Heat OFF.

(3) A-4 cameras ON one frame per second for a period of 25 minutes after leveling off.

(4) Comments on the defrost system.

(5) Counter number when doors are opened and closed and when heating elements are turned OFF.

5. Raintightness

The raintightness of the RB-47E airplane shall be investigated during flight operation: Fly the airplane in a heavy rain with the crew compartment unpressurized for a sufficient length of time (maximum 30 minutes) to thoroughly check for water tightness.

NOTE: Immediately after landing inspect the airplane for leakage and trapped water, using procedure as called for in the ground test conditions (Paragraph B of the outline of the test).

Particular note should be made of any cases where the leakage found may adversely affect the service life of any part of the airplane or its components.

DATA: Pilot - (1) General comments on raintightness.

(2) Time of flight in rain.

(3) IAS, altitude, and OAT.

Co-Pilot - (1) General comments on raintightness.

[redacted]

Navigator - (1) General comments on raintightness of the escape hatch and nose canopy.

Technical Observer (Ground) - (1) Amount and location of trapped water.

(2) General comments on raintightness.

Checked by *Louis F. Sandberg Jr.* (signature)
Flight Operations Engineer

Checked by *J. H. Goodell* (signature)
Flight Test Project Pilot

Approved by *[signature]*
Chief of Flight Test

CALC			Camera Compartment and Cabin Defrosting, Alternator Water Separator, and Raintightness Test	RB-47E AF51-5258
CHECK				
APR				WD-13564
APR			BOEING AIRPLANE COMPANY, SEATTLE 14, WASH.	
				9-1-7

[redacted]

INSERT NO. 3

BOEING AIRPLANE COMPANY

Document WD-12829

TITLE: General Instrumentation

Pages 150-2 and 150-7 only

Pages 165 and 166

CALC	JBK	10-22-55	REVISED	DATE	INSERT NO. 3 GENERAL INSTRUMENTATION	Insert No. 3
CHECK						RB-47E
APR					BOEING AIRPLANE COMPANY	WD-14018
APR					WICHITA DIVISION WICHITA 1, KANSAS	PAGE
CONTRACT NO.					Insert No. 3 WD-14018	164

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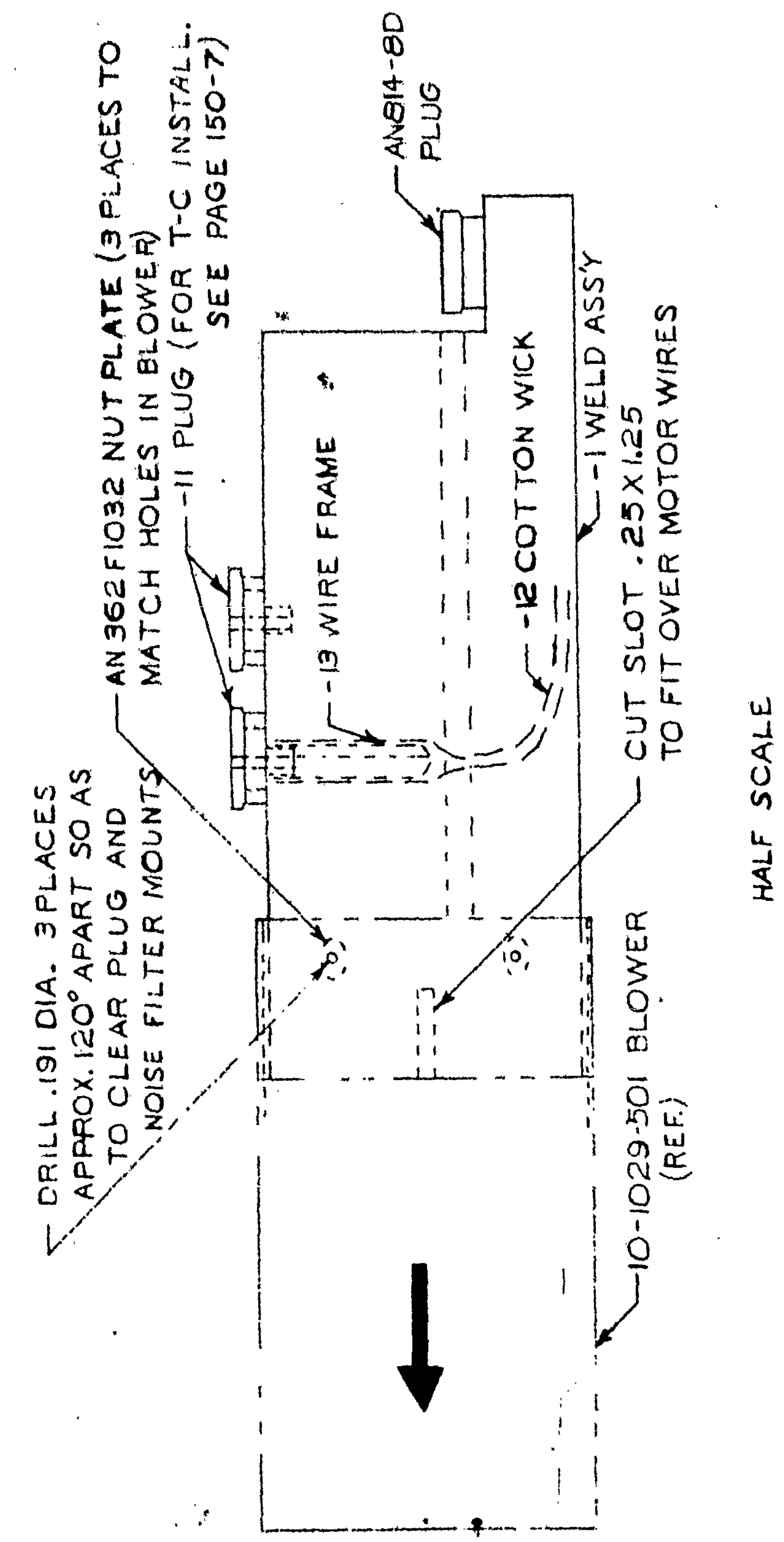
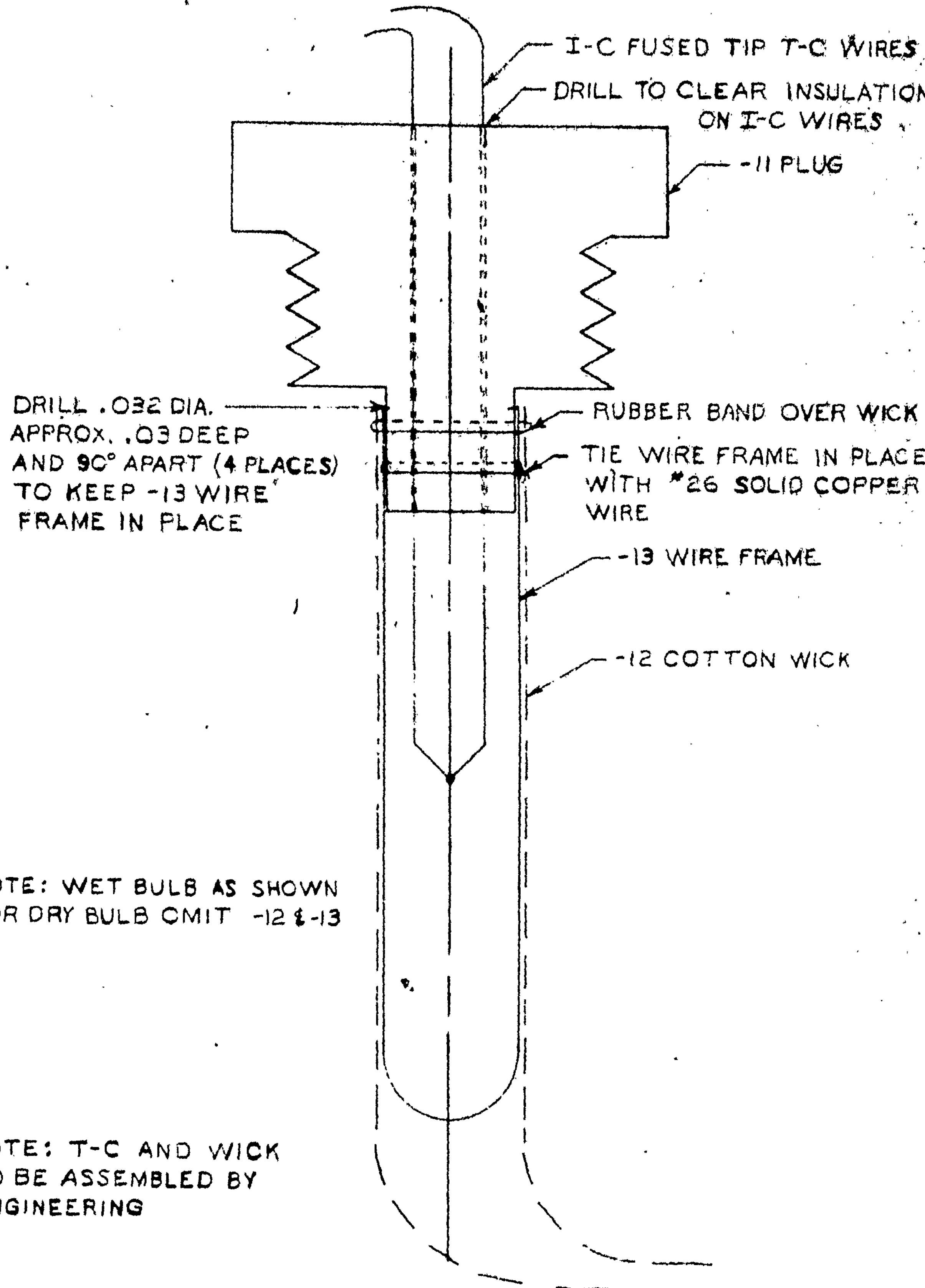


SK-40465-0

CALC. JMc	8/11/53	REVISED	DATE	PICKUP ASSEMBLY WET AND DRY BULB TEMPERATURE	GEN.
CHECK	9/.../53			BOEING AIRPLANE CO. WICHITA DIVISION — WICHITA 1, KANSAS	WD 12829
APP.	9/11/53				PAGE 150-2
CONTRACT NO.				Insert No. 3 WD-14018 Page 165	



NOTE: WET BULB AS SHOWN
FOR DRY BULB OMIT -12 & -13

NOTE: T-C AND WICK
TO BE ASSEMBLED BY
ENGINEERING

SK-40465

CALC	J Mc	8/12/53	REVISED	DATE	PICKUP ASSEMBLY WET AND DRY BULB TEMPERATURE	GEN.
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APR	[illegible]	9.14.53				
APR						PAGE 150-7
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INSERT NO. 4

BOEING AIRPLANE COMPANY

Engineering Laboratory Report M-1307

TITLE: Calibration of 6-44294 Venturi In RB-47E Nose Window Exterior Defrost System

Pages 1 through 9

Pages 168 to 177

CALC	JBK	10-22-55	REVISED	DATE	INSERT NO. 4 CALIBRATION OF 6-44294 VENTURI IN RB-47E NOSE WINDOW EXTERIOR DEFROST SYSTEM	RB-47E
CHECK					BOEING AIRPLANE COMPANY WICHITA DIVISION WICHITA 1, KANSAS	WD-14018
APR						PAGE 167
APR						
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BOEING AIRPLANE COMPANY
WICHITA, KANSAS

LABORATORY REPORT NO.
[redacted] M-1307 DATE 11-7-55

MODEL RB-47E CONTRACT NO.

TITLE CALIBRATION OF 6-44294 VENTURI IN RB-47E NOSE
WINDOW EXTERIOR DEFROST

ISSUE NO. TO DATE

SHORT TITLE
(For Classified Data)

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PREPARED BY May A. Pecht

Checked [redacted] BY Donald L. Gillespie

APPROVED BY GHGregg for JDMcEwen 11/7/55

APPROVED BY

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TABLE OF CONTENTS

SUMMARY

This report presents the calibration of the 6-44294 Venturi which was used on RB-47E Airplane AF 51-5258 during Flight Test WFT-709.

The venturi was satisfactorily calibrated and a curve determined using the flow parameter $\frac{W\sqrt{T}}{P_{s1}}$ vs. pressure ratio $\frac{P_{s2}}{P_{s1}}$ as shown on Figure 2.

REFERENCES

1. Laboratory Report M-1169 - Calibration of Camera Compartment and Cabin Defrosting System Instrumentation in Airplane AF 51-5258

2. Laboratory Work Assignment 1307 - Calibration of 6-44294 Venturi, Nose Window Exterior Defrost

3. WFT 709 - Outline for Flight Test - Nose And Camera Compartment Defrosting System.

4. WD-13563 - Instrumentation for Flight Testing RB-47E Airplane AF 51-5258.

CALC			REVISED	DATE	SUMMARY AND REFERENCES	
CHECK	[illegible]	4-9-58				RB-47E
APR					BOEING AIRPLANE COMPANY	M-1307
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INTRODUCTION

Calibration of this venturi is necessary to provide air flow performance of the RB-47E nose window exterior defrosting system during flight. After calibration of the original unit had been made, the airplane venturi and its instrumentation was replaced by this venturi, requiring an additional calibration. This test is for the calibration of the second system. The original system was calibrated as reported in Reference 1.

In accordance with the instrumentation requirements of Reference 3, RB-47E AF 51-5258 has been instrumented per Reference 4 for flight test WFT 709 (defrosting).

DESCRIPTION OF TEST SPECIMEN

The venturi calibrated during this test was made according to BAC Drawing 6-44294 with the following dimensions:

Inlet = 1.415 In. Throat = 0.366 In.

This venturi is used to meter air for the nose window exterior defrost system on the RB-47E airplane.

TEST SET-UP AND PROCEDURE

The equipment used in this test is listed as follows:

1. Altitude Chamber
2. Rotameter - Schutte and Koerting, PO-47-11-145
3. Venturi 6-44294, with Flight Test Instrumentation
4. Manometer Bank, H_2O, Hg
5. Temperature Indicator - Brown
6. Airplane Ducts for Proper Configuration

The above equipment was set up as shown in Figure 1. The ducts immediately preceding the venturi were used to simulate airplane configuration in order to obtain airflows similar to those obtained in the actual airplane installation.

The air flow was varied from 0 to 4 pounds per minute through the venturi at stabilized altitude increments of 5,000 feet from sea level to 40,000 feet. Readings were taken from eleven pressure ratios at each altitude increment. Data was recorded as required to determine the calibration curve for this venturi.

The temperature T and pressure P_s taken at the inlet of the rotameter was used to correct the rotameter readings in this test.

TEST RESULTS AND DISCUSSION

The flow parameter $\frac{W\sqrt{T}}{P_{s1}}$ was used in this test as in Reference 1. The data used for Figure 2 is the average of data collected at the various altitude readings of each of the eleven pressure ratios used in the test.

The curve derived from the data collected is essentially the same as the one in Reference 1.

SAMPLE PROBLEM

The following is a sample problem to facilitate the use of Figure 2.

Temperature = 70°F

Differential Pressure = 300 MPH measured on air speed indicator

Venturi inlet Static Pressure = 30.0 In. Hg abs.

$\Delta P = P_{s1} - P_{s2}$

Where: ΔP = Differential Pressure - In. Hg

P_{s1} = Venturi inlet static pressure - In. Hg abs

P_{s2} = Venturi Throat Static Pressure - In. Hg abs

ΔP = 300 MPH = 3.38 In. Hg from chart (Airspeed vs Differential Pressure)

P_{s1} = 30.0 In. Hg

$P_{s2} = P_{s1} - \Delta P = 30.0 - 3.38 = 26.62$ In. Hg

Pressure Ratio $= \frac{P_{s2}}{P_{s1}} = \frac{26.62}{30.00} = 0.888$

Using the above pressure ratio of 0.888 from the curve on Figure 2:

$$\frac{W\sqrt{T}}{P_{s1}} = 1.035$$

Where: W = Air Flow - lb/min

T = Absolute Temperature - °R

P_{s1} = Venturi inlet static pressure - In. Hg. abs.

Then: $T = 70°F = 460+70 = 530°R$

P_{s1} = 30.0 In. Hg. abs.

Therefore: $W = \frac{1.035\ P_{s1}}{\sqrt{T}} = \frac{1.035 \times 30}{\sqrt{530}}$

W = 1.35 Lb/Min Airflow Through Venturi

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CALC					SAMPLE PROBLEM
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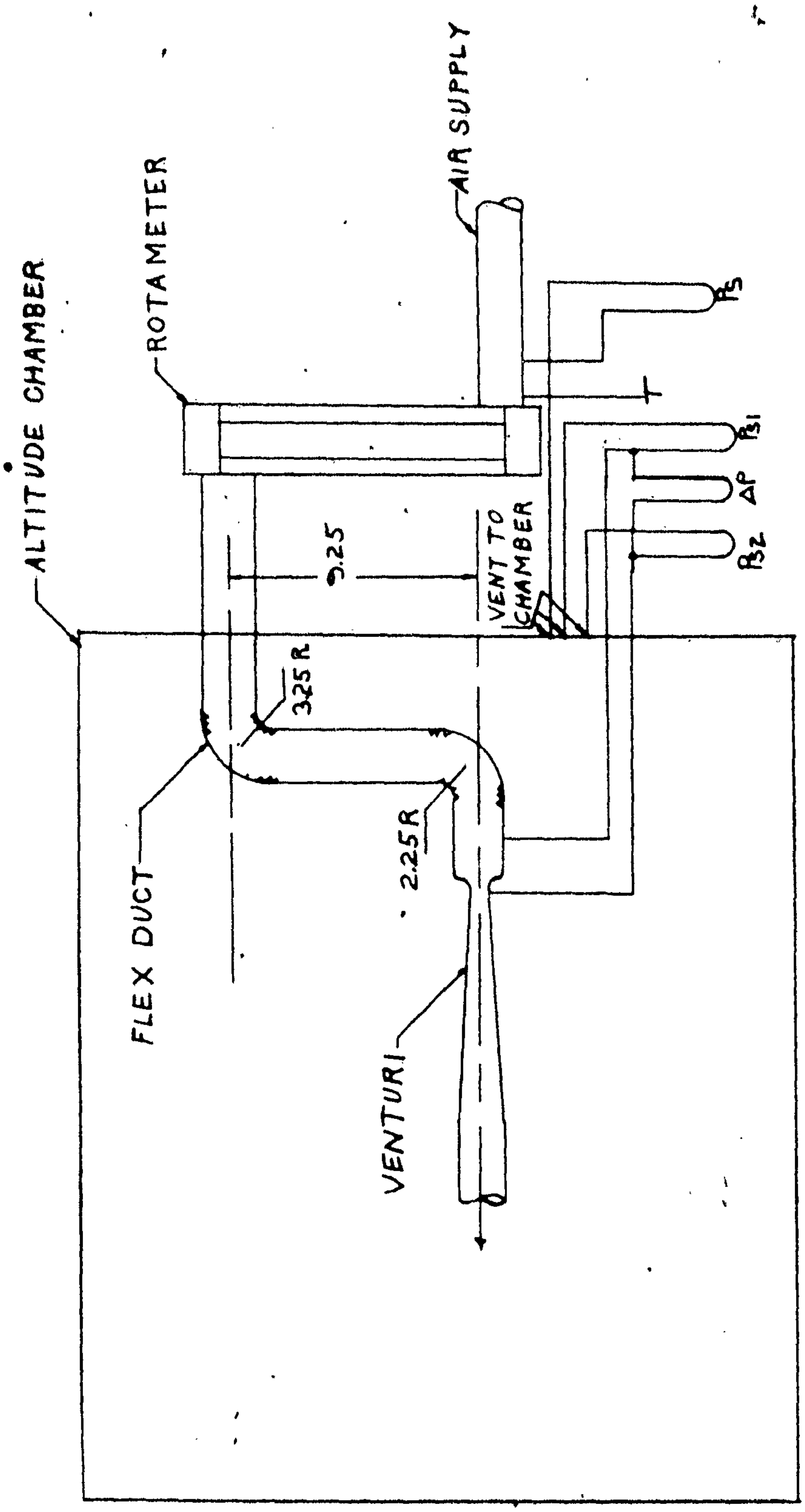
CONCLUSIONS

It is concluded as a result of this test that the data collected makes a curve which is suitable for use in determining the air flow performance of the RB-47E nose window exterior defrost system during flight test WFT 709. (Reference 3). The theoretical flow through a venturi when plotted forms a parabolic curve like the one shown by Figure 2, confirming the validity of the data.



SCHEMATIC OF 6-44294
VENTURI CALIBRATION

			REVISED	DATE		
CALC	M'PECHT	3-14-55			VENTURI TEST SETUP	FIGURE 1
CHECK	[illegible]	4-9-55				RB47E
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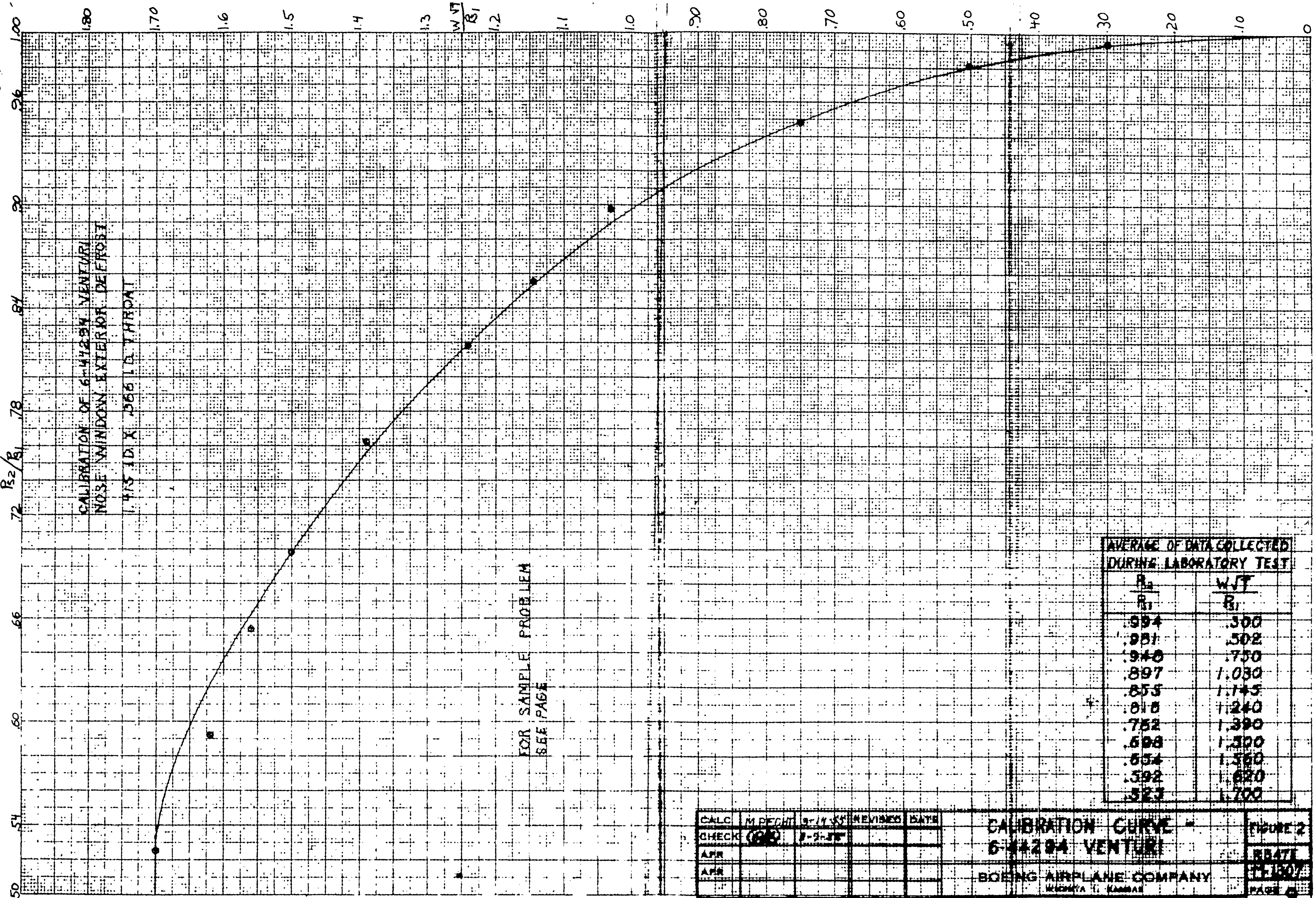

AVERAGE OF DATA COLLECTED DURING LABORATORY TEST

$\frac{R_2}{R_1}$	$\frac{W\sqrt{T}}{R_1}$
.994	.300
.981	.502
.940	.750
.897	1.030
.855	1.145
.818	1.240
.752	1.390
.698	1.500
.654	1.560
.592	1.620
.523	1.700

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CALIBRATION CURVE
6-44294 VENTURI
BOEING AIRPLANE COMPANY
WICHITA, KANSAS

FIGURE 2
RB47E
T1-1507
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